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THE AMERICAN ROENTGEN RAY SOCIETY: ITS PREVIOUS, PRESENT-DAY AND FUTURE IMPORTANCE TO RADIOLOGY AND MEDICINE*

PRESIDENT'S ADDRESS

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THE American Roentgen Ray Society, from its early years to the present day, has had an enviable reputation as one of the most outstanding radiological societies in the world. Today, it is planned to discuss the role of the Society in the advancement of our Specialty to its present high plane in medicine, and its function in continuing the forward progress of Radiology and the radiologist.

The history of our Society is presented in an excellent article by Christie in the July, 1956, issue of our JOURNAL. He states that the members of our Society, in its first decade, 1900–1910, not only laid the sound foundation for medical radiology in America, but were its chief architects and builders. It is indeed fortunate that a number of great scientists and physicians of that and later periods realized the potentiality of radiant energy and especially roentgen rays, and therefore became interested in the development of Radiology. Christie mentions Nikola Tesla and Charles P. Steinmetz, electrical geniuses and inventors, H. Clyde Snook, developer of the interrupterless transformer and Arthur W. Goodspeed, Professor of Physics at the University of Pennsylvania, the Society's third president, in 1903, as some of the early non-medical members.

Honorary membership was conferred by the Society on a number of physicists, because of their eminence and contributions to Radiology, including Coolidge, Duane, Kaye, Rollins and Shearer. The first three were Caldwell Lecturers, as was Robert A. Millikan, Nobel Prize winner. Honorary membership was also extended to certain outstanding radiologists in England, France, Sweden and Germany, and some of these brought their special knowledge to our Society through feature lectures at our annual meetings, while others freely interchanged information with our members visiting their laboratories.

* From the Departments of Radiology, Germantown Hospital and Temple University. Presented at the Fifty-ninth Annual Meeting of the American Roentgen Ray Society, Washington, D. C., September 30–October 3, 1958.

With great wisdom and foresight our predecessors in the Society emphasized, during its early years, the importance of the clinical approach to radiologic problems, and thus set the pattern of practice that resulted in the recognition of our specialty as the practice of medicine. Most of these men were excellent clinicians, and therefore their radiologic results were correlated with the clinical findings, before an opinion was rendered. Also, many of them were leaders in medicine, and therefore Radiology gained rapidly in stature, despite its technical aspects.

It is impossible to fully credit the contributions these leaders made to Radiology during its early period, but they exerted great favorable influence, at a time when it was needed. Undoubtedly, their ability and eminence induced a large number of capable men to enter Radiology and the latters' enthusiasm and ability resulted in rapid further development of our specialty. A number of these second generation radiologists either saw service in World War I, or became full-fledged specialists shortly thereafter. Most of them became members of the Society, because of its high standing, and our records show that they not only participated actively, but rose to leadership in our organization and in other medical societies. These men were the teachers of many present-day radiologists. Therefore, the American Roentgen Ray Society has filled a significant role in the dissemination of radiologic information from its inception to the present through its members, meetings and JOURNAL.

The Annual Meeting represents the outcome of coordinated efforts, through the preceding year, of a large number of Society members, including the Officers, Executive Council, Program Committee, Scientific and Local Committees, the Director of the Instructional Courses, the Manager of the Annual Meeting, the Editor and his associates, the participants in the various sessions and Mr. Clifford Sherratt, honorary member. The latter makes arrangements for hotel accommodations, placement of exhibits and equipment, rooms for members and guests, registration, meetings and social functions. The Local Committee assists with registration and entertainment for members and their wives, and is charged with the responsibility of publicity and press relations. The latter is ably directed by Mr. Hugh Jones, Director of Public Relations of the American College of Radiology. The College annually appropriates a sum to help defray Mr. Jones' expenses incurred in this activity.

The Program Committee, under the chairmanship of the President-Elect, makes every effort to present a well-balanced program with appeal to the various interests of those attending the meeting. The papers presented in the scientific sessions deal with techniques and findings that result from clinical investigation and research in University and Community Hospitals. The highlight of these sessions is the Caldwell Lecture, given by an eminent scientist, to honor the memory of one of our outstanding members, Dr. Eugene W. Caldwell. As stated by Christie, the wide interest of the Society is nowhere better exemplified than in the choice of these lecturers. There has been great diversity of subjects and scientific background of the brilliant men chosen for this lecture. This year's lecturer, Dr. Leo G. Rigler, longtime Professor of Radiology, great teacher and clinician, adds luster to the Society and further honor to himself by joining the ranks of previous lecturers.

A number of presentations are augmented by scientific exhibits on the same subject. These exhibits are of great teaching value, and therefore a large number of radiologists apply themselves diligently to the task of studying the material and questioning the exhibitors. Those who master some of the many lessons to be learned from these exhibits leave with a wealth of knowledge. The Society must take its share of credit for making this education possible through its Exhibitors and the Scientific Exhibits Committee. This year, Doctors C. Gianturco, R. Marshak and

T. Leigh have done a great service to radiologists by obtaining approximately fifty exhibits.

The Commercial Exhibits play an important role in the education of the radiologist concerning advances in equipment and accessories. The radiologist learns about new technical developments and can determine the feasibility of incorporating them in his department or office. The Instructional Courses attract a large number of radiologists, because they have wide appeal and afford an opportunity to obtain first-hand knowledge from a specialist within the field of Radiology that is otherwise unavailable. Dr. Harold O. Peterson, Director, has arranged sixty-four periods of instruction using a large number of teachers. The educational value of this part of the program cannot be overestimated.

The JOURNAL has been a potent force in medical education since it was started in October, 1906, as the QUARTERLY JOURNAL OF ROENTGENOLOGY. It is published under the direction of the Publication Committee of our Society, this year chairmanned by Dr. Herbert M. Stauffer, and edited by Doctor Lawrence Reynolds and his staff of Associate Editors and three editorial assistants. Doctor Reynolds began his editorial duties in January, 1930, and except for a few years, 1947–1949, when he was President-Elect and President, he has continued to make a magnificent contribution to the JOURNAL and the Society as its Editor. Others, including Doctor Preston M. Hickey, the first Editor, Doctor James T. Case, Doctor H. M. Imboden, Doctor Arthur C. Christie, and Doctor Merrill C. Sosman, served admirably in the capacity of Editor. Doctor Traian Leucutia has served as one of the Associate Editors, and also as Abstract Editor, and in these capacities has made meritorious contributions. A recent volume contained 427 condensed articles, received from 170 individuals who abstracted material from Journals throughout the World. These abstracts contain valuable information in capsule form that is available to the reader at little cost of time. There is an average of 185 text pages devoted to clinical and fundamental research papers in diagnosis and therapy, book reviews and the abovementioned abstracts of significant and current literature. Therefore, the JOURNAL provides an invaluable medium for transmittal and exchange of information about all phases of radiology. Printed monthly copies have increased from 7,200 in 1954 to 9,500 in 1958. It has the largest circulation of any radiological periodical being sent to subscribers in all parts of the world.

The Editor and Associate Editors attribute this remarkable increase, in part at least, to a method of arranging submitted articles, so that those pertaining to some special branch of radiology are published together. Thus, comprehensive coverage of a branch or topic is included in each monthly issue. For example, in the August number of Volume 76, are articles dealing with Neurologic and Neurosurgical Radiology; in the September issue are papers on Pediatric Radiology; in October, Cardiovascular Radiology; and in November are found numerous articles on Roentgen Therapy. This plan is being followed, and will continue indefinitely, unless experience indicates the necessity of a change in policy. The Editor publishes acceptable articles that have been presented at the Annual Meetings of the American Roentgen Ray and American Radium Societies, and from contributors that submit papers of high quality and sufficient interest to appeal to members and subscribers.

The Society is in an enviable position in the world of science. Its admission standards are high and therefore membership is evidence of achievement in Radiology. It has representation to our National Academy of Sciences; in fact, a number of national specialty societies in medicine do not have representation, so our Society is especially honored. The Society furnishes representatives to a number of national scientific organizations and committees. It nominates three of its members to the American Board of Radiology, and one

member to serve on the Board of Chancellors of the American College of Radiology. Our organization is one of the sponsors of the Inter-Society Committee for the Registry of Radiologic Pathology, and it underwrites with the Radiological Society of North America compensation for Fellows appointed to the Registry. Thus it assists young men to educate themselves in special phases of Radiology, at the postgraduate level, after finishing a residency in Radiology.

In 1955, the Executive Council, under the Chairmanship of Doctor W. Edward Chamberlain, contracted with management consultants to evaluate the administrative organization and fiscal arrangements of the Society to determine whether requirements imposed by its programs and activities were being fulfilled to best advantage. A thorough study of important areas, including fiscal requirements, accounting system and procedures and contractual business relationship between the Society and publishers of the JOURNAL, resulted in recommendations that were unanimously accepted by the membership, in order to improve the efficiency of various operations and functions. Three years' experience with these changes indicates their great value and suggests the importance of a similar survey before the end of the present decade.

In conclusion, it is obvious that the American Roentgen Ray Society through its members, meetings and JOURNAL, has played a distinguished role in the understanding, development and application of roentgen rays, radium and radioactive isotopes for medical and non-medical uses. It has been repeatedly said that the discovery of roentgen rays has resulted in greater medical advances than any other single development. Therefore, the contribution of our Society to Radiology and medicine has been and will continue to be of great significance. Its future importance to man through medicine and non-medical science will be directly proportionate to the efforts expended by its present and future members, and therefore all of us and those to follow must continuously strive for even greater heights than those attained in the Society's illustrious past.

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COMMON SENSE EVALUATION OF RADIATION EXPOSURE IN CLINICAL RADIOLOGY*

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What is the proper length for a man's legs? "Long enough to reach the ground."

A. LINCOLN

Science is for the investigator what common sense is for the ordinary man.

CONANT

SINCE the Report to the Public of the National Academy of Sciences, much has been written on the subject of radiation injury, and general apprehension has been raised to a high level. I would like to see less emotion in our fears and more logic. We ought to try to get our feet back on the ground.

The radiation effects that most need discussion are the late sequelae from comparatively small exposures—cancer, leukemia, premature aging, and genetic mutations.

CANCER

Cancer of the skin, of hands particularly, has afflicted many radiologists and has appeared many years after quite small exposures many times repeated as well as after single large doses. Yet it is comparatively infrequent considering the very large number of persons exposed. Therapeutic irradiations and internal irradiation (radium in the bones) have produced a few cancers, but diagnostic radiology is practically negligible as a cause of cancer of skin or bone.

LEUKEMIA

Leukemia has been reported to be ten times as frequent among radiologists as among other physicians. The significance of this has lately been questioned, because the reported difference could conceivably be the consequence of the differing age compositions of the two series.

Wald[5] reports 53 cases of leukemia among the survivors of the bomb at Hiroshima. Those who were closest show a leukemia rate 30 times as high as those who were 2 miles or more away. In the British report[2] on 13,000 patients given heavy spinal irradiation for spondylitis, the frequency of leukemia is also closely correlated with the dose, but fits a quadratic relationship quite as well as a linear one. The cases mostly appeared between one and six years after exposure, whereas cases are continuing to appear at Hiroshima. Either of two equations fits the data well:

$$\text{Yearly increase in leukemia} = 10^{-7} \times (\text{rads in the spine, averaged})$$

$$\text{Yearly increase in leukemia} = 1.8 \times 10^{-6} \times (\text{megagram rads})^2$$

If the second equation be used, the effect of a small dose, say 10 r to the body from one side, is negligible. If the first equation be used, 10 r to the entire spine would lead to a 10 per cent increase above the natural incidence. This is small compared with the difference between Denver and San Francisco. Curiously, the leukemia incidence goes contrary to the level of natural radiation for this pair of cities.

PREMATURE AGING

Animals exposed to large amounts of radiation and not dying of it within a month never recover completely from the effects. They are sensitized to future irradiation in the lethal range (about 10 per cent of the effect of first dose persists). They often become gray. Changes in renal arterioles are observed. These are all characteristics of aging, and the impression is confirmed by their early death, regardless of

* From the United States Naval Radiological Defense Laboratory, San Francisco. The opinions presented are those of the author and do not necessarily express the policy of the Navy.

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the apparent cause of death. The shortening of the life span is correlated with the amount of radiation received. The correlation is not certain, however, for very small exposures.

Man's great variability and the impossibility of controlling the environment for a large experimental sample throughout a long lifetime makes the observations on length of life of almost no use in deciding how much exposure to radiation affects longevity. Dr. Grubbe, who suffered the first roentgen-ray burn in the United States (in 1896, while still a manufacturer of roentgen-ray tubes), lived to be over eighty years old, having had some 60 operations for keratoses and cancers on his hands. Dr. Pfahler practiced radiology from 1899 until the day he died of leukemia in 1957.[3] Anecdotes prove nothing, of course, except that we need more observations.

GENETIC MUTATIONS

It is now many years since Muller showed that radiation induces mutations which are then inherited. The induced mutations do not differ in kind or in the manner of inheritance from spontaneous mutations already known. Timofeev's work has been abundantly confirmed, showing that the frequency of mutations (specific, or in general) bears a linear correlation with the dose of radiation, and that the effects are irreversible. This gives us great confidence in extrapolating the genetic injury down to very small doses indeed. The conclusion seems inescapable that even cosmic rays produce some mutations, although apparently accounting for only about one tenth of the natural mutation rate.

Russell's demonstration that mammals (mice) are ten or fifteen times as susceptible as insects to genetic injury by radiation induced us to re-evaluate our criteria for radiologic protection.

The public fear of radiation was further augmented by propaganda against nuclear warfare based on the radiation hazards from fall-out of fission products from bomb testing. Many persons have become afraid to have even dental or pulmonary roentgenograms made.

The Executive Committee of the NCRP hastened to lower the maximum permissible limits for exposure to radiation both within and without controlled areas (employees and casual persons). Many states and municipalities began to plan legislation and the NCRP brought out a handbook designed to advise the lawmakers, which has proved to be moderately successful.

This is the situation in which we begin to suspect that not everybody's feet are on the ground.

REACTION TO THE NATIONAL ACADEMY OF SCIENCES' REPORT

Radiologists have been publishing reports of radiation injuries and warnings of radiation hazard for half a century. Percy Brown's *Martyrs to Science through the Roentgen Ray* appeared years ago. The American Medical Association Council reported on radiation hazards. The National Committee on Radiation Protection (NCRP) has been active for nearly thirty years and was greatly expanded in membership ten years ago in order to cover the enlarged area of interest engendered by the new high energy machines and nuclear fission and its products. Its work has resulted in publication of a dozen handbooks by its sponsor, the National Bureau of Standards. A few state governments adopted regulations against radiation hazards. The radiological societies took cognizance and had editorials published. The general response to this professional work and propaganda was on the whole not remarkable. This was only realized after seeing the very lively general reaction to the National Academy of Sciences' Report.

RELATIVITY

Roentgen rays and other ionizing radiations are nearly imperceptible. Experience is limited to persons using the proper instruments. Acquaintance with acute radia-

tion reactions in man is extensive only among radiation therapists and irradiated cancer patients. Consequently, the general public has had no chance to develop a realistic approach to radiation. The transition from foolish complacence to baseless fear and on to unrealistic action could have been predicted. Some serious attempts at public education by the American College of Radiology and Federal Agencies are noteworthy.

Radiation injuries—radiation hazards—need to be considered and evaluated in relation to the other hazards of our complex civilization. The barriers we set and the embargoes we enforce need to be adjusted to the good uses of radiation that such barriers might deny us. Account should be taken of our gradual change in attitude. As our lives become progressively more secure, the value we set on security continues to rise. It is a heart-breaking paradox that the era when European civilization reaches the acme of security for such a large portion of the world's population contains the moment in history when the human species is fixing to destroy itself.

When we are dealing with chances of death, we can consider it from several moral and practical standpoints—religious, patriotic, military, medical, actuarial (life insurance), industrial, mercantile (consumers). No doubt you can think of other categories. This would provide material for a book. Here I wish to pick and choose among the several attitudes.

Speaking as a scientist, I realize that human life is quantized, that every life is unique. Speaking morally, I realize that every life is infinitely precious to itself. Physicians properly hold to this absolute valuation of a human life. No effort is too great in the attempt to save a life, however poor the life may seem to those who are struggling to preserve it. Prison physicians will mobilize all the resources of modern medicine to save a murderer's life so that he may be properly tried and hanged.

To deal with lives in the same way when they make up whole populations is an intellectual and emotional impossibility, I believe. My criterion is the obvious impossibility of effective response to the logical consequences. Missionaries, religious and medical, do attempt to respond. The souls they save may stay saved. When the population is in equilibrium with its food supply, as so often is the case, the lives saved are soon to be paid for by an equal number of deaths from starvation, for in the long run as many die as are born. I do think that tender hearts are to be admired and cherished. But is it not clear that the missionary's response to death in the teeming populations of the orient is only effective in keeping the missionary's heart from breaking?

To a biologist, the high death rate in such a population is a biological phenomenon, and so the death of each person in it becomes a "statistic." For this I shall be called hard-hearted, which I hope that the biological part of me will continue to be. But if we deal with death as a biological phenomenon, there is hope that we shall be able to develop the logic, the means and the motivation to respond effectively in terms of the well-being of the persons making up that population.

In regard to the hazards of radiation we wish to take effective action. In order to make this possible, I propose to deal with human lives relatively, not absolutely.

INDUSTRIAL CONTROL

The internationally accepted maximum permissible dose of radiation is 5 r per year of total body exposure. This is calculated to keep the life-shortening less than half a year even if a man should be exposed to the limit every year for thirty years. Some think the shortening might be five years. Anyhow, such a change in life expectancy among a fraction of the fraction of persons employed where there is radiation is quite unobservable. The increased chance of acquiring leukemia from 150 r total exposure is about one in 10,000, compared to three or four chances per 1,000 (thirty years exposure to risk) natural incidence. Such an

increment, 3 per cent "above background," would be reliably observable only if we could follow 1,000 persons so exposed. At the Hanford works only a couple of employees get as much as 5 r in any year, some years nobody gets that much. The maximum permissible dose is therefore seen to be set below the level of observability for leukemia.

The genetic hazard from a gonadal exposure equal to the maximum permissible dose for ten years from the age of twenty until on the average half of a person's children are born is calculable in terms of increased mutation rate. The 50 rad gonadal dose resulting from exposure to the full maximum permissible dose every year is near what is generally believed capable of doubling the natural mutation rate. Any dominant mutants will show up in the first generation. The exposed man's children would have an extra 45 chances per 1,000,000 of being chondrodystrophic, and an extra 15 or 23 chances per 1,000,000 of having retinoblastoma. The recessive mutations would be lost in the general pool of mutant genes that the human race has accumulated from times past and not yet gotten around to deleting by the Darwinian process of differential mortality. If enough parents were exposed to the maximum permissible dose for many of their years before having children, the addition to the pool of mutant genes would be important. Such a thing might happen from worldwide fallout. It has been calculated that continuous exposure of a population to the "doubling dose" would build up the pool of recessive genes so that the rate of appearance of the associated defect would increase about 1 per cent per generation. Microcephaly, for example, would have an incidence of 55 per 1,000,000 after 10 generations had been continuously exposed.

In view of the genetic hazard, the National Committee on Radiation Protection reduced even more drastically the permissible exposure rate outside controlled areas, setting the limit at 0.5 rem per year, and advised the addition of 5 half-value layers to the boundaries of controlled areas where the barrier was sufficient only to meet the old maximum permissible dose (15 r/yr.). This appears to me unrealistic and hard-hearted besides. It amounts to telling the employee that he must accept a radiation injury if he wishes to have the job. I think the personal injury from radiation in a plant where the NCRP requirements are met (5 rad/yr. maximum) can be truthfully called zero. The genetic injury concerns the whole population, not particularly the person exposed. It is the average exposure that counts, not the maximum to some individual. At the Hanford plant the number getting as much as 4 r in any year is about one out of 13,000 employees under film badge control. The average exposure is 0.2 r per year. Supposing there came to be a hundred plants that large where employees were exposed to radiation with adequate control, then 0.2 r per year would be expected for more than a million employees. Averaged over the whole 100,000,000 population in similar age group, the exposure is seen to be only a fraction of what comes from the potassium within our bodies.

It appears that the present maximum permissible dose which is designed to protect employees from personal injury is, in practice, amply sufficient for the genetic requirement and no greater protection need be demanded for persons outside the plant.

But take care lest your ear be caught by a devotee of the absolute approach. The Hanford employees, averaging 0.2 r exposure per year, were subjected to twice the natural amount of radiation. This presumably added 10 per cent to the natural mutation rate. The British Committee collected 15 mutations for which a statement of the frequency has been published. The total frequency is 543 per 1,000,000 per generation. There could be a hundred times as many spontaneous mutations as yet unidentified and with frequency unknown. If the natural frequency of mutations is actually 5 per cent per generation, then five years of operation at the Hanford plant is responsible for man-made muta-

tions amounting to 10 per cent of the natural mutations for 5/30 of the effective exposure time of a generation. This appears to mean about 11 extra mutations put in. Most of these are estimated to be deleterious, and some day (in some future generation) 11 extra persons have to die prematurely in order to get the mutants out again.

If you take these in isolation and without any sense of humor, you can call it the assassination of 11 persons, and inexcusable and intolerable. If you take it in context, you must measure this embodiment of a calculated bad chance against the other chances associated with the Hanford operations. We don't know them all. The ordinary accident rate has been smaller than the industrial average. The largest risk connected with Hanford is, of course, the risk of war. It may never be known whether Hanford diminished that risk as was planned, or increased it. Either way the risk concerned not 11 lives but 100,000,000. A good sense of balance will hardly permit 11 unidentified lives in the indefinite future to weigh against even a small influence on the associated risk to 100,000,000.

It is amazing that the people of the United States have acquired so much confidence in science that they will accept the scientist's estimates of injuries that are completely unobservable. If I were not myself so confident of our mathematical models, I would call it tilting at windmills.

We should no doubt try to bring these small effects under observation. To make the distinction between a first power and a second power regression of leukemia induction on total body dose would require several times as many subjects, even if one then remained content to predict the effect of the smaller doses by extrapolation. To validate the relationship at the 5 r per year level of exposure might require similar observations on half a million such therapy cases, which obviously do not exist.

Gopal-Ayengar and a committee of WHO[1] are to study the effects of irradiation over many past generations on about 100,000 fisher folk whose villages are on beaches of monazite sand. The local exposure rate is much above the world average, with maximum reported as 2.6 r per year. He has calculated that it is just within the range of possible significant observation. To determine experimentally the aging effect of doses such as we are considering for industrial or even military permissible limits promises to be almost beyond reach. One should work with mice because they are small and short lived. If one could find a strain in which irradiation produces granulocytic leukemia, as it usually does in man, and if one had luck and no epizoötic infections, a colony of 100,000 mice might give some answers.

The reason for citing these difficulties is to emphasize the fact that we have hitched our radiation protection wagon to an unobservable star, and are likely to lose our sense of humor if not our reason on account of it.

DUTY OF THE CLINICAL RADIOLOGIST

Having laid the above massive foundation, the next step is to build the dwelling. We have to live with radiation. Radiologists are the men who have the science and the experience. This gives them the duty to explain radiation to everybody who will listen. Radiologists are the ones who use radiation on human beings. In this they have a duty to see that the harm to human health does not overtake the benefits to human health.

Therapeutic radiation is used mostly against cancer. Since the disease is presumably fatal, it is warrantable to risk the patient's life to whatever degree is necessary in order to cure him. I do not believe that I have seen irradiations undertaken that have a 90 per cent chance of killing the patient, although such would be thinkable if one carried the stated policy to its logical conclusion. In the first place, nobody can estimate prognosis with that precision. In the second place, there is no technique of irradiation that offers a neat "kill or cure"

result. In the third place, cancers that would demand a 90 per cent lethal irradiation do not as a rule offer even a 5 per cent chance of cure, however large the dose. Looking over the long term results of our own patients cured of cervical carcinoma, I do not observe any further shortening of life expectancy correlated with the addition of external irradiation to the intracavitary radium in those who have remained cured. Even if there were, a few years off the end of a life are not too high a price to pay for the saving of many years in the middle of life. The important thing is that the radiologist should know whether his choice of a certain plan of therapy entails a determinable amount of aging. He will then not choose a plan needlessly harmful, and he will consider whether surgical treatment might have as good a chance to cure yet avoid this newly appreciated drawback.

Irradiation in the treatment of nonmalignant diseases is chosen less often than in former years. A number of diatribes have been published as well as some more moderate reports. But the change in policy comes not so much from fear of radiation as from the availability of more effective remedies, especially the antibiotics and the steroids. A few superstitions have been buried, as, for example, the use of roentgen radiation for whooping cough. The connection between thymic irradiation in infancy and thyroid cancer in childhood still lies in a field of controversy. Fortunately, such roentgen therapy has already been pretty well abandoned along with the foolish conviction that because a baby's thymus filled up to a large size (with blood) in the inspiratory phase of crying, it was pathologic and must be treated.

The inefficient external irradiation of hyperplastic thyroids was abandoned when Plummer showed that operative treatment could be reasonably safe on a patient properly prepared. The antithyroid drugs transferred the hazard from the neck to the bone marrow. Now, with I^{131}, the hazard is back in the neck again. It may be twenty years before we know whether a 10,000 rad dose from internal irradiation is carcinogenic.

A few therapeutic practices persist that seem to ignore the sequelae of irradiation. One that most radiologists disapprove of has not entirely been given up by the otologists; namely, the radium treatments in the fossa of Rosenmüller. It may be that our apprehensions are not justified. On the other hand perhaps enough time has not yet elapsed for the carcinogenic capabilities to show up in the mucosal scars. We do know that iatrogenic cancer is infrequent in the buccal and lingual scars from radium and roentgen-ray therapy.

DIAGNOSTIC RADIOLOGY

Few of those who read this will remember how radiology was practiced before the use of films and intensifying screens and before the Coolidge tube made control of voltage better than a trial and error affair. In those days some diagnostic exposures came close to the epilation dose. The enormous reduction in necessary exposure that the screens afforded is now being repeated "in cascade" by the development of fluoroscopic image amplifiers. One looks happily into a future when the necessary diagnosis can be accomplished with truly negligible exposure of the patient.

As long as we are still using "standard techniques," it behooves us to respond realistically to the charge that diagnostic radiology is adding gonadal exposure about equal to the natural irradiation.

The actual amount of gonadal exposure is not known precisely. Some estimates in the United States are four times as high as the accepted estimate for England. We surely must be mindful of the National Committee's dictum that the population-wide average gonadal exposure shall be kept below a total of 14 r in the first thirty years of life. At present we seem to be running neck and neck with the natural radiation in consuming the principal portion of this permissible range.

First, there are the obvious medical diagnostic requirements and the real, though

tiny biological injuries, both of which are reasonably susceptible to measurement, or at least estimate. Then there is professional and public psychology, which is more difficult to be sure about in our estimates. In my view, psychological reactions are as much facts of life as physical ones, however unsatisfactory I may find them to deal with.

Patients seem determined to put all of the emphasis on the least important things. Nearly all the anxious inquiries have been about chest survey films and dental roentgenograms. Equally remarkable is the opinion of a conscientious radiological physicist that many clinical radiologists are taking the matter quite casually and are disinclined to give much weight even to the procedures that give most of the gonadal dosage (excretory urograms, for example). It is inevitable that a professional lifetime of experience should make for fixity of practice. It is amazing that radiologists have long had their therapy machines standardized but almost none of them knows the output of his diagnostic apparatus. Working thus in an atmosphere of rule of thumb, and the rule different for each diagnostic installation, the diagnostic radiologist has almost no data in his books or in his head about the biological exposures entailed in roentgenography. Published measurements are not lacking, only there has been no incentive for their clinical use. Add to this the fact that the bad effects from exposures at diagnostic level are entirely unobservable. It is obvious that a campaign to reduce diagnostic exposures toward minimum efficient levels will have much inertia to overcome.

The Genetics Committee of the National Academy of Sciences recommended that records be kept of every exposure for every patient, and that the total be kept below 50 r before the age of thirty. If the committee had included a practicing radiologist, he could have made them understand how little such a record would mean. Even therapy records are not always good enough for the estimate of total radiation energy absorbed. Pilot programs are under way in a few places to see what can be accomplished when one tries to do as the committee recommends. The International Commission on Radiological Protection has recommended against universal recording of personal exposures.[4]

In setting a limit on the personal exposure, the Genetics Committee distracted attention from the significant parameter; namely, the average exposure. For the genetic effects it makes no difference how large a dose a few among the fecund group may get, just so there may be enough cases of small exposure to offset it.

Something might be done, however, to keep the radiologist apprized of how much total patient irradiation he has given, without any account of how many patients it was spread over. I have been watching with good hope the experiments of two radiologist friends who are attacking the problem of integrating fluoroscopic exposures. Both are attacking on the same principle; namely, to integrate the total light from a fluorescent screen set in the useful beam. This automatically keeps an account of roentgen-ray output, area irradiated and duration of exposure. I have thought that a piece of photographic film or paper of sufficiently slow speed (or a chemical dosimeter) might integrate the exposures for the whole day, or for the work of each fluoroscopist.

This scheme of integrating exposures without reference to the patient is applicable to roentgenography as well. What is particularly lacking is information as to how much reaches the gonads. We may yet see State Departments of Public Health issuing integrating codpieces and requiring their routine use.

In the meantime practical radiologists have an opportunity and a duty. They also have a road block; namely, the unwillingness of experienced X-ray technicians to change their ways. Through sweat and tears they have learned how to avoid retakes. They do not willingly risk having to pass that way again. If the new generation

of radiologists were themselves expert technicians, then the wedding of science to technology would be in the hands of more effective leaders, and the ideal could be attained more quickly.

IDEAL RADIOGRAPHY

We are trying to arrive at the optimum: (1) The radiologic procedure best adapted to the diagnostic problem presented; (2) the roentgenogram with the most information; and (3) a technique that yields such a roentgenogram with the least absorbed dose (a) to the gonads and (b) to the whole patient.

The fitting of the radiologic attack to the patient's doctor's needs is a matter for medical acumen. It requires plus brains rather than minus rads.

The roentgenogram with the most information, after the best "view" has been chosen, means correct exposure and processing. I owe to Earl Miller the pertinent concept of sufficient contrast. A barium enema study shows every pertinent outline as well against a gray background as against a black one that required five times the exposure. Unless the barium is very well diluted, a very heavy exposure indeed is needed to show polyps within the lumen.

For some faint contrasts, like nonopaque stones and renal hilus, the optimum is achieved with a very heavy exposure and a very bright viewing light.

In chest roentgenography it is amazing how little difference in visibility of a soft tissue shadow (water against air) is made by moderate under- or over-exposure, or by marked changes in quality.

When one actually measures visibilities, the old prejudice in favor of low kilovoltage for chest roentgenography falls to the ground. Soft tissue shadows of borderline contrast are somewhat better shown at 100 kv. with 3 mm. Al filter than with softer qualities.

Iodized contrast media cast the best shadow at 70 kv. peak, but for faintly calcified stones the softer the quality the better, provided the stone does not move. Movement that destroys the sharpness of outline does very serious harm to visibility of faint shadows, consequently movement should be considered far more important than kilovoltage.

For the trabecular pattern of bone a lower kilovoltage is advantageous if movement is assuredly prevented. Fine focus and immobilization will do even more for visibility. Moreover bone usually has contrast to spare.

In all the above there is many an opportunity to reduce the exposure of the patient by raising the kilovoltage, and to increase the diagnostic use by lowering the kilovoltage for the right purpose. The latter consideration should be taken as the overriding one. A little predictable increase in chances of premature aging or genetic mutation is nothing as compared to a diminished chance of diagnostic success.

THE THREE-CORNERED FILM

My last recommendation is the simplest, the most effective and apparently the most difficult to get adopted. It consists in limiting the exposure to the area of interest. The way to achieve this is to use a square or iris diaphragm, continuously adjustable, with concentric light beam to show the size and location of the irradiated field. Inspection as to its proper and efficient use is achieved by the radiologist himself, with no extra physical operations. He simply demands that 3 corners of the film show white. Because the cut-down in size is around the periphery, the reduction in exposed area can be great without encroaching on the region of interest.

Obviously, the gonads should be covered against the useful beam in every case if that area is not needed in the roentgenogram.

CONCLUSIONS

Fear of radiation has become general. Due to general ignorance the fear is largely misapplied. Radiologists have an opportunity and a duty to correct the unwholesome aspects of unreasoned fear. For this

the radiologist must himself be well informed.

The late pathologic sequelae of small exposures are mentioned and an attempt made to put them in proper quantitative relation. Some of the recommendations for radiation protection are criticized as illogical. However, a plea is made not to ignore or override patients' foolish prejudices. Every foolish question presents an opportunity for education.

The opportunities for iatrogenic injuries in radiologic practice are mentioned, especially the unobservable injuries. In spite of the small amount of the injury done in diagnostic radiology, it is recommended that every radiologist conduct his practice in such a way that everyone may become aware of his care to give no unnecessary exposure.

The development of methods to sample or to integrate the exposures of all patients appears more promising than schemes to record individual accumulations of diagnostic exposures.

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RADIATION DOSE REDUCTION IN DENTAL ROENTGENOGRAPHY

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MUCH attention has been given to the subject of radiation dosage received by patients in the course of general roentgenographic examinations, but scant notice has been accorded in the radiologic literature to the matter of excessive dosages[16,26] delivered to patients and personnel during routine dental roentgenographic examinations. This is unfortunate because, as our experimental results and those of others show, these exposures are excessive. Radiologists will readily appreciate the physical reasons for this. Dentists have been equipped until recently with roentgen-ray machines of low kilovoltage and current capacities, coarse mechanical timers accurate only in seconds, with no provision for filtration of the beam or use of limiting diaphragms. Moreover, most dentists use a short focal-film distance of only 8 inches instead of long-tube techniques[18,23] and many prefer the standard, relatively slow dental film or single emulsion types to the fastest ones recently developed by the leading companies. Therefore, it is apparent to the trained radiologist that most means of reducing dosages are either not provided or are not being utilized by the average dentist.*

As in medical roentgenography, there has been an increasing rise of dental roentgenographic examinations during the past generation, especially of full-mouth studies. There has been particularly an increase in cephalometric examinations in the practice of orthodontia[8] where younger persons undergo frequent exposures to the head and neck. Stanford[19] in 1953 was among the first to call attention to the dosages received by the reproductive organs in patients having full-mouth dental roentgenographic examinations. More recently Budowsky *et al.*,[2] using conventional dental roentgenographic techniques, have made careful measurements of radiation exposures to the head and to the skin of the abdomen during oral roentgenography and found the doses to the latter varying from 0.45 r to 5.6 r per full-mouth examination. Nolan and Patterson[16] and Nolan[15] have recorded total dosages to the head and neck of up to 315 r for full-mouth roentgenographic examinations. They have also surveyed dentists and their technicians and have found dose rates to personnel in many busy offices as high as 2.0 r per hour.

If we are to be seriously concerned about the small amounts of radiation permissible according to the geneticists[11–14] and physicists[20] during a lifetime, and especially during the procreative years, then the field of dental roentgenography deserves special attention. At least three states, Texas, New York and Pennsylvania, now require 2 mm. Al filtration in the roentgen-ray tube head.† This and other measures are neces-

* Murray, Dwight H. (Pres. A.M.A.), Pamphlet reprint, "Are X-rays Dangerous to You?" from the American Weekly, Jan. 6, 1957, by American College of Radiology, says: "Therefore, if you trust your dentist's ability to fill or cap a tooth, you probably should be able to trust him in the matter of x-rays."

Also Editorial in *J. Am. Dent. A.*, 1956, *53*, 361–362 entitled Dental Roentgenography; Patient's Fears Unfounded: "The recent publicity given reports of a study conducted by the U. S. National Academy of Sciences on the biological effects of radiation has caused a great number of people to become unduly alarmed about the possible harmful effects of dental and medical roentgenography. . . . Although it is unfortunate that the publicity aroused so much apprehension, it did have the salutary effect of reminding members of the health professions of the well-known and long-known but frequently disregarded dangers of radiation. . . ."

† Texas State Department of Health, Austin, Texas: Regulations on Radiation Exposure, Sept. 1, 1956.

New York State Department of Health, Albany, N. Y.: The Sanitary Code, Chp. XVI, 1956.

Pennsylvania State Department of Health, Division of Environmental Health: 2.5 mm. Al total filter required under new regulations, Jan. 15, 1958.

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sary to reduce radiation levels in dental roentgenography to lowest possible levels.

In order to determine the minimum dose which may be necessary to obtain satisfactory dental roentgenograms, the output of a roentgen-ray machine was measured at various combinations of physical factors. The tube was operated at 20 ma. and the applied voltage was varied in steps from 60 to 100 kv. peak, focus to film distance from 8 to 16 inches, and filtration from inherent to 3 mm. Al. Dose measurements were made both in air and with 4 inch thick pressdwood backscatterer with a standardized thimble ionization chamber. These results are shown in Figures 1 and 2. Having determined the total dose at 8 and 16 inch distances, then the fraction of a dose

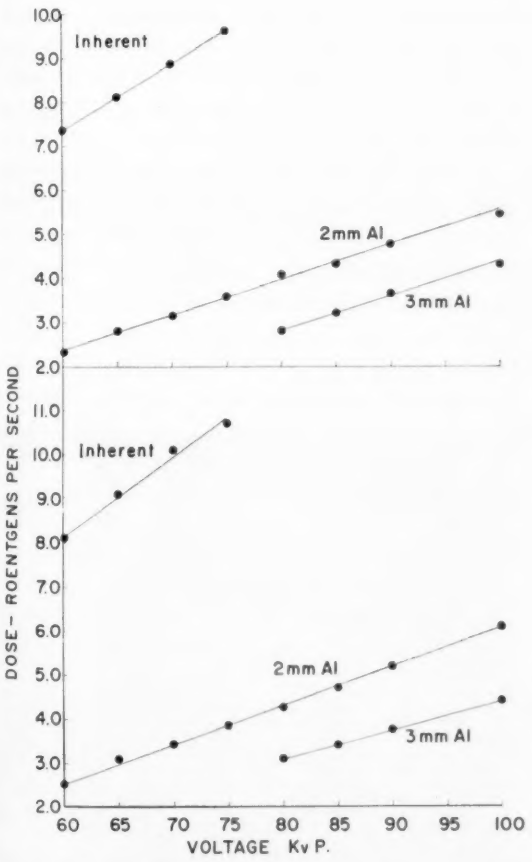

FIG. 1. Roentgen output of a dental roentgen-ray machine at target-chamber distance of 8 inches. *Upper:* in air; *lower:* with 4 inch thick pressdwood backscatter.

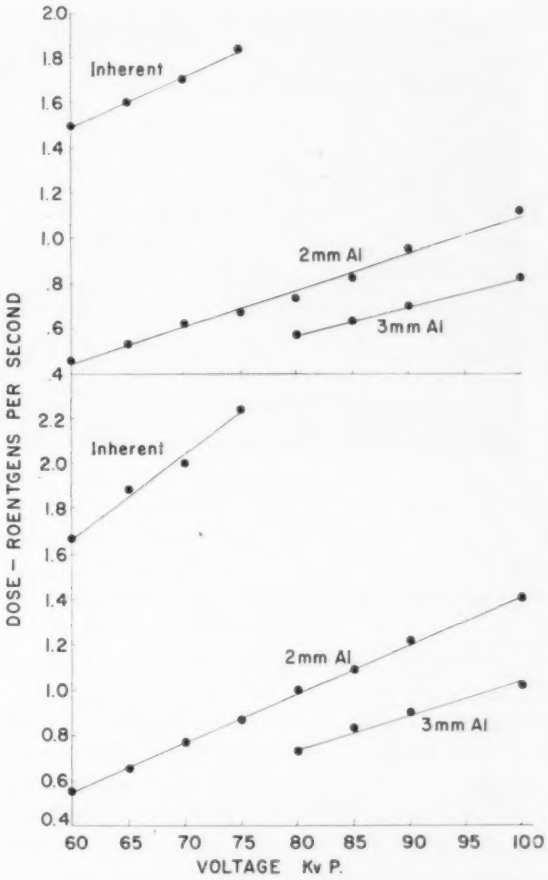

FIG. 2. Roentgen output of a dental roentgen-ray machine at target-chamber distance of 16 inches. *Upper:* in air; *lower:* with 4 inch thick pressdwood backscatter.

required for the shortest possible exposure time for satisfactory dental roentgenograms with relatively fast and slow films was obtained. These results are shown in Figures 3 and 4.

These data will be readily understood by the trained radiologist as he realizes the necessity for the shortest possible exposure time to reduce distortion from motion and to produce a sharp image. Also, it is apparent that the smaller the dose used to produce a roentgenogram, the less radiation the patient and, indirectly, the operator would receive. It is seen in Figure 5 that with conventional technique the dentist produces a roentgenogram of very good contrast with a resultant high dose of the order of 16.2 r per film. By increasing fil-

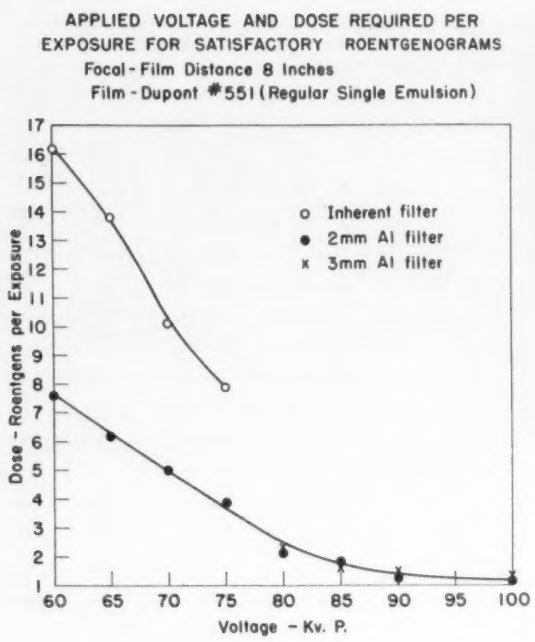
APPLIED VOLTAGE AND DOSE REQUIRED PER EXPOSURE FOR SATISFACTORY ROENTGENOGRAMS
Focal-Film Distance 8 Inches
Film - Dupont #551 (Regular Single Emulsion)
o Inherent filter
• 2mm Al filter
x 3mm Al filter
Dose - Roentgens per Exposure
Voltage - Kv. P.

FIG. 3

tration by only 2 mm. Al (Fig. 6), the dose to produce the same roentgenogram is reduced to 7.6 r—a reduction of more than 50 per cent. Then, as shown in Figures 7 and 8, by increasing voltage to 90 and 100 kv. peak, filtration to 2 and 3 mm. Al,

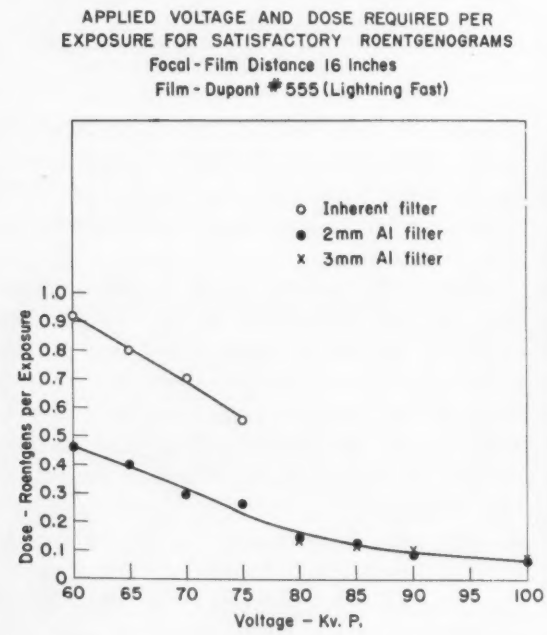
APPLIED VOLTAGE AND DOSE REQUIRED PER EXPOSURE FOR SATISFACTORY ROENTGENOGRAMS
Focal-Film Distance 16 Inches
Film - Dupont #555 (Lightning Fast)
o Inherent filter
• 2mm Al filter
x 3mm Al filter
Dose - Roentgens per Exposure
Voltage - Kv. P.

FIG. 4

FIG. 5. Exposure made at 60 kv., 20 ma. 2 seconds, 8 inch distance, inherent filter only, DuPont no. 551 film. Radiation dose at film 16.2 r.

focus to film distance to 16 inches and using the fastest film, satisfactory roentgenograms could be made with 0.09 r and 0.08 r, respectively, in 1/10-second exposures. This dose amounts to 1/180th of the original dose of 16.2 r.

It is somewhat difficult to determine the exact total dosage per full-mouth examination, but the ingenious method of Budowsky *et al.*[2] is a close approximation. By placing the ionization chamber at each successive position for dental roentgenography while doing a full-mouth examination, they arrived at dosages to the skin in each area

FIG. 6. Exposure made at 60 kv., 20 ma., 3 seconds, 8 inch distance, 2 mm. Al filter, DuPont no. 551 film. Radiation dose at film 7.6 r.

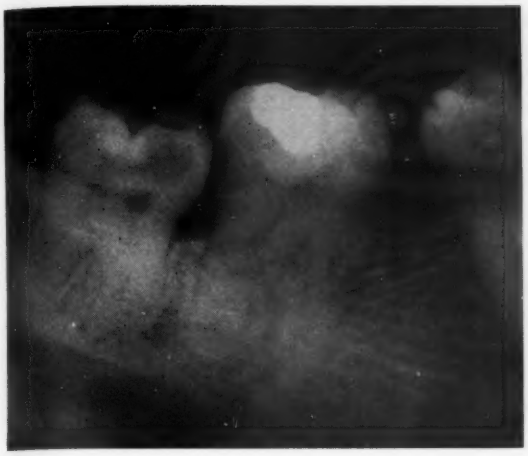

Fig. 7. Exposure made at 90 kv., 20 ma., 1/10 second, 16 inch distance, 2 mm. Al filter, DuPont no. 555 film. Radiation dose at film 0.09 r.

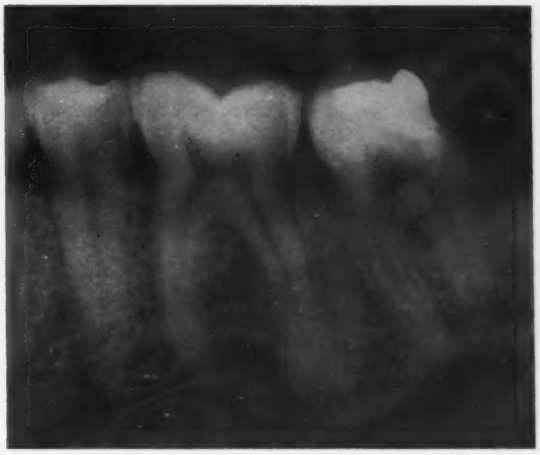

Fig. 8. Exposure made at 100 kv., 20 ma., 1/10 second, 16 inch distance, 2 mm. Al filter, DuPont no. 555 film. Radiation dose at film 0.08 r.

varying from a low of 46.0 r to a high of 76.9 r. Nolan and Patterson, referred to above,[15,16] recorded total dosages up to 315 r to the head and neck during full-mouth roentgenographic examinations. To get some approximation of the fraction of a dose that may be received by the patient, we measured the exit or transmitted dose using a 5 inch thick rice phantom. The percentage transmission of the dose measured in air for each volatge and filter is given in Table I.

As may be seen when the voltage is increased, there is a greater transmission of the beam through the phantom. Then too, for the same applied voltage a more filtered roentgen-ray beam is more penetrating and consequently gives greater transmission. It is well known that, of a given roentgen-ray beam, the greater the fraction that is transmitted, the lesser the fraction absorbed and the smaller the amount of radiation to which the patient is exposed. Using an especially prepared manikin* we recorded doses to the right and left sides of the neck and thyroid during full-mouth roentgenographic examination. These are shown in Table II for various roentgenographic techniques and different amounts and kinds of filtration. In Table III are listed doses to gonads and skin of the abdomen using the same varieties of techniques and filters. It will be seen that the 90 kv. technique with 2 mm. Al added filter results in a very small dose which can be reduced to an infinitesimal amount by a combination of copper and aluminum filtration and high kilovoltage,

* Loaned to us through the courtesy of Thomas A. Lincoln, M.D., Director Health Division, Oak Ridge National Laboratory and Edwin D. Gupton, M.S., Oak Ridge, Tennessee. Lincoln, T. A., and Gupton, E. D. Radiation dose to gonads from diagnostic x-ray exposure. *J.A.M.A.*, 1958, *166*, 233–239.

Table I

PERCENTAGE TRANSMISSION OF DOSE MEASURED IN AIR THROUGH RICE PHANTOM 5 INCHES THICK. TARGET-CHAMBER DISTANCE—16 INCHES

Filter	Voltage—kv. peak							
	60	65	70	75	80	85	90	100
Inherent	6.6	8.1	10.0	11.4				
2 mm. Al	13.1	15.1	21.0	25.4	28.8	33.5	35.1	41.6
3 mm. Al					31.6	39.7	45.7	51.8

TABLE II

RADIATION DOSES TO HEAD AND NECK. FULL MOUTH—
14 EXPOSURES (MANIKIN)

Techniques	Neck Right Side	Neck Left Side	Over Thyroid	Total Time Used Per Full Mouth
Conventional 65 kv. 10 ma.—Inherent Filter 8 in. Distance—Regular Film	35.6 r	35.5 r	34 r	26¼ sec.
2 mm. Al Filter 70 kv. 10 ma. 8 in. Distance—Fastest Film	5.5 r	5.5 r	5 r	10 4/10 sec.
2 mm. Al Filter 90 kv. 15 ma. 16 in. Distance—Fastest Film	1.8 r	1.8 r	1.7 r	1 2/10 sec.
0.375 mm. Cu+0.5 mm. Al 65 kv. 10 ma. 8 in. Distance—Fastest Film	2.6 r	2.7 r	2.4 r	22 sec.
0.375 mm. Cu+mm. Al 90 kv. 15 ma. 16 in. Distance—Fastest Film	800 mr	800 mr	700 mr	2 1/10 sec.
Bite Wings Only Conventional Technique (see above)	5 r	5 r	4.8 r	2 films 2½ sec.
Bite Wings Only 2 mm. Al 90 kv. 15 ma. 16 in. Distance—Fastest Film	300 mr	300 mr	300 mr	2 films 2/10 sec.

Note: The above figures are averages of 10 readings. Manikin through courtesy of Lincoln and Gupton.

available in the new type of dental roentgen-ray machines.

Recently, an excellent method of reducing radiation output of the standard dental roentgen-ray machine was devised by Yale and Goodman.[26] They used filters of 0.375 mm. copper and 0.5 mm. aluminum with 65 kv., 10 ma. current and ultra-speed films to produce a dose of 0.24 r in air with a 2 second exposure. A diagnostically improved roentgenogram is obtained by this method, having a long tonal scale devoid of excessive contrast, but the principal objection is the long exposure time (2 seconds) compared to the 1/10th second time possible with higher kilovoltage. It is obvious from photographic principles that there will be less distortion from motion in a film made at 1/10th of a second than in one made at 2 seconds.

SUMMARY AND CONCLUSIONS

1. It is evident that one of the largest sources of imperfectly controlled radiation emanates from dental roentgen-ray machines. This is because they are operated at relatively low kilovoltages and current values for long times of exposure, with no diaphragming of the beam or filtration of it, short focal-film distances and, often, by using standard, relatively slow films.

2. This overdosage can be corrected by employing at least 2 mm. Al filtration in the present machines (or 0.375 copper plus 0.5 mm. Al as recommended by Yale and Goodman) in addition to a lead diaphragm

TABLE III

RADIATION DOSES TO GONADS AND SKIN OF ABDOMEN USING VARIOUS TECHNIQUES IN DENTAL ROENTGENOGRAPHY. FULL MOUTH—14 EXPOSURES (MANIKIN)

Techniques	Skin of Abdomen	Ovaries	Testes	Total Time Used per Full Mouth
Conventional 65 kv. 10 ma. Inherent Filter 8 in. Distance—Regular Film	33.6 mr	22.1 mr	11.5 mr	26¼ sec.
2 mm. Al Filter 70 kv. 10 ma. 8 in. Distance—Fastest Film	26.4 mr	17.4 mr	10.7 mr	10 4/10 sec.
2 mm. Al Filter 90 kv. 15 ma. 16 in. Distance—Fastest Film	6 mr	1 mr	1 mr	1 2/10 sec.
.375 mm. Cu+0.5 mm. Al 85 kv. 10 ma. 8 in. Distance—Fastest Film	10 mr	4 mr	3 mr	22 sec.
.375 mm. Cu+3 mm. Al 90 kv. 15 ma. 16 in. Distance—Fastest Film	2.6 mr	.4 mr	.06 mr	2 1/10 sec.
Bite Wings Only Conventional Technique (see above)	4.8 mr	3.2 mr	1.7 mr	2 films 2½ sec.
Bite Wings Only 2 mm. Al 90 kv. 15 ma. 16 in. Distance—Fastest Film	1.86 mr	.16 mr	.14 mr	2 films 2/10 sec.

Note: Manikin through courtesy of Lincoln and Gupton.

and ultra-speed film.

3. To take full advantage of known physical principles in reducing radiation exposure, higher kilovoltage dental roentgen-ray machines capable of developing 90 or better kv. with current capacities of 15–20 ma., timers accurate to 1/20th of a second, long-cone techniques, and fastest films are recommended.

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RIGHT ANGLE ROENTGENOGRAPHY OF THE GASTROINTESTINAL TRACT*

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RIGHT angle roentgenography of the upper gastrointestinal tract has proved its merit over a period of years in a number of radiologic clinics. However, the importance of right angle views is still not fully appreciated by many practicing radiologists. In orthopedics, neuroradiology and other comparable fields, the need for right angle studies has long been established and accepted as routine procedure. In this presentation we will illustrate the need for similar routine right angle studies of the barium filled upper gastrointestinal tract in delineating and accurately evaluating intra-abdominal masses, as well as intrinsic diseases of the stomach and duodenum.

Although a clinically palpable mass is sometimes difficult for the radiologist to detect, with a little ingenuity, every mass large enough to be clinically palpable is generally demonstrated roentgenographically. When a mass is not clinically palpable, but is nevertheless present, the responsibility for the radiologist becomes full-blown. Here, the demonstration by the radiologist of such a clinically undetectable mass is gratifying. The entire armamentarium at his disposal must be assiduously and intelligently employed in such instances. Yet, there are still limitations to the roentgen modality, even with right angle views, and occasionally an abdominal mass escapes detection by both the clinician and the radiologist, only to be demonstrated on the operating table or in the autopsy room.

Historically, a solution to the problem of demonstrating upper abdominal masses was first attempted by Engel and Lysholm in 1934.[1] These authors postulated that with gastric pneumography "the retrogastric soft tissues are equivalent to the thickness of the antero-posterior diameter of the lumbar body at any level measured." This dictum has proved inaccurate innumerable times, particularly because of differences in body habits, posture and other related factors. Poppel, Sheinmel and Mednick[2] in 1949, in a critical appraisal, emphasized that the concept of Engel and Lysholm was inaccurate. Poppel and his co-workers at that time recommended the supine translateral view of the barium filled stomach. These authors concluded "that the retrogastric soft tissues are equivalent in thickness to the anteroposterior diameter of the lumbar body at any level measured, provided one has ascertained what part of the stomach crosses the midline, at what vertebral level it crosses and then restricts the retrogastric measurements to this level only." Poppel *et al.* admitted that under certain circumstances, this statement was not infallible, since obesity and ascites could alter the measurements.

In 1951, Sheinmel and Mednick[5] discarded the supine translateral view, claiming that its use was limited. Instead, they stressed the importance of the left lateral upright roentgenogram for an evaluation of the retrogastric space on the left side, and the right lateral recumbent roentgenogram for an estimate of the retrogastric space on the right side. Sheinmel and Mednick studied 200 normal persons, measuring the retrogastric space with reference to the habitus of the individual. They found that the barium filled stomach and

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duodenum in normal individuals varied considerably with the habitus. In asthenics, in the right lateral recumbent and the left lateral upright roentgenograms, the stomach was found to be considerably closer to the spine than in hypersthenics. The descending duodenum was elongated and also closer to the spine in the asthenic individual. In hypersthenics the stomach showed an increased distance from the spine, as did the duodenal segment, with relative widening of the duodenal loop. The sthenic individual showed findings somewhere in between the two extremes. In translateral decubitus roentgenograms, with the patient supine, the stomach was closer to the spine in the sthenic individual and much further removed from the spine in the hypersthenic. For purposes of brevity, examples of the normals are omitted and may be found in the papers of Poppel *et al.*, and Sheinmel and Mednick, noted above. Table 1 is a modified summary of the measurements of the retrogastric space for individuals with varying habitus determined by Sheinmel and Mednick.[3] These measurements are probably the most valid to date; yet, a reliance on mensuration alone will often lead to erroneous conclusions, and the present authors have been led astray in the past, not infrequently, by an unrealistic dependency on the measurements given in this table. In neuroradiology, for example, when dealing with a fixed space enclosed in the bony frame-work of the skull, measurements may be relatively accurate, but are still only measurements and must be used intelligently against a frame-work of the entire set of findings. In a distensible abdomen, where a great number of variable factors enter into the problem, the value of mensuration alone is quite dubious. It has been our practice, therefore, to evaluate an increase of the retrogastric space critically, by looking for additional clues, small though they may be, to indicate evidence of extrinsic pressure.

An extrinsic pressure defect may present itself subtly in many ways and in any one of a number of views. Before even any contrast medium is employed, preliminary and plain roentgenograms of the abdomen may indicate partial or complete obliteration of the psoas muscle outline or significant scoliosis or displacement of various organs from their normal position. A mass may be visible in the frontal plane, but supplementary lateral exposures are frequently necessary to aid in delineating the character and location of the mass. Although gas in the intestines is often condemned as a nuisance in evaluating a plain roentgenogram of the abdomen, air is a natural contrast medium. Thus, an air-filled viscus may be displaced by an intra-abdominal mass in either the frontal plane or lateral views. Intrinsic lesions in a gas-filled viscus, such as the stomach or colon, may sometimes be seen. Even the supine or prone translateral exposure of the abdomen, prior to the administration of barium may be utilized with the aid of gas in the intestine to detail the presence of a mass.

Figure 1, *A* and *B* demonstrates the presence of suprarenal lymph node metastases from bronchogenic carcinoma seen in the left upper quadrant of the abdomen in

TABLE I

NORMAL LINEAR MEASUREMENTS IN CENTIMETERS FROM THE POSTERIOR SURFACE OF THE STOMACH TO THE ANTERIOR VERTEBRAL SURFACE AT LEVELS INDICATED FOR AVERAGE HEIGHT AND WEIGHT

Status	Right Lateral Recumbent Position	Left Lateral Recumbent Position
Normal Hyposthenic		
Cardia	3.5 cm.	0.5 cm.
Media	5.5 cm.	3.0 cm.
Antrum	2.5 cm.	4.0 cm.
Normal Sthenic		
Cardia	1.5 cm.	0–0.5 cm.
Media	6.5 cm.	4.0 cm.
Antrum	3.75 cm.	5.0 cm.
Normal Hypersthenic		
Cardia	2.5 cm.	0.5 cm.
Media	8.5 cm.	8.5 cm.
Antrum	7.5 cm.	8.5 cm.

FIG. 1.

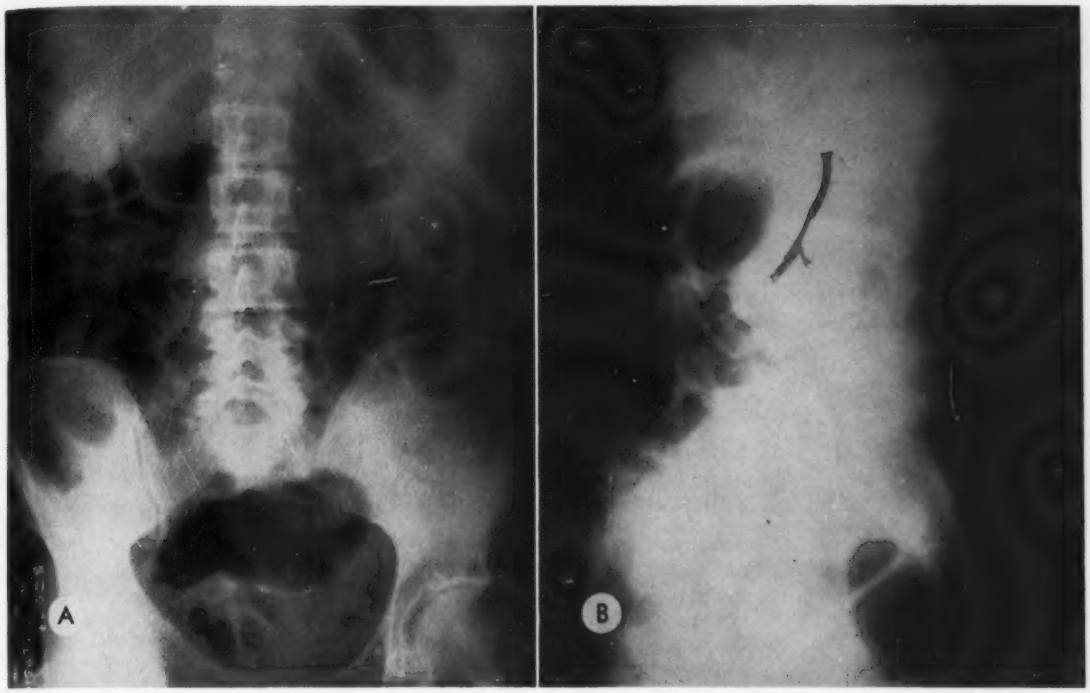

FIG. 1. (*A*) A vaguely defined soft tissue haze is seen over the upper abdomen, particularly in the left upper quadrant. (*B*) A large soft tissue mass is seen in the upper portion of the abdomen in the mid-plane in this lateral view, with the mass well demarcated anteriorly and inferiorly by the gas-filled stomach and intestine. The position of the contrast medium-filled collecting system of the left kidney in an intravenous urogram done at this time is demarcated by the curved pencil line. Diagnosis: Lymph node metastasis from a bronchogenic carcinoma.

the anteroposterior and left lateral views.

Routinely, after the oral ingestion of barium, in searching for upper intra-abdominal masses, we make the following six exposures of the barium filled upper gastrointestinal tract: posteroanterior upright, left lateral upright for the left retrogastric space, posteroanterior and right lateral recumbent for the right retrogastric space and anteroposterior supine and translateral supine for the midline component of the retrogastric structures. We agree with Poppel and his co-workers that the translateral supine roentgenogram is quite important and may be the only exposure that enables delineation of a mass. Although the measurements of Sheinmel and Mednick are kept in mind, the presence of actual indentations and shelving is considered conclusive and definitive evidence of the presence of a space-occupying mass. Actual displacement of the barium-filled stomach, duodenum or other segments of the small intestine is already a late sign and generally indicates a mass of considerable size. In addition to indentation, shelving and displacement, a "pad" type of defect may be demonstrated along the lesser curvature surface of the opacified stomach in the posteroanterior Trendelenburg position. This "pad" sign must be evaluated carefully as to the location and nature of the mass. Such a differentiation is facilitated by extrapolating the defect and noting the approximate character and size of the organ or mass producing the defect. Figure 2, *A*, *B* and *C* shows the "pad" sign successively in 3 cases—hepatomegaly, carcinoma of the body of the pancreas and enlarged kidney due to pyelocaliectasia.

Right angle views may be used to advantage to demonstrate masses in the mid-abdomen, particularly just below the level of the stomach and duodenum. In Figure

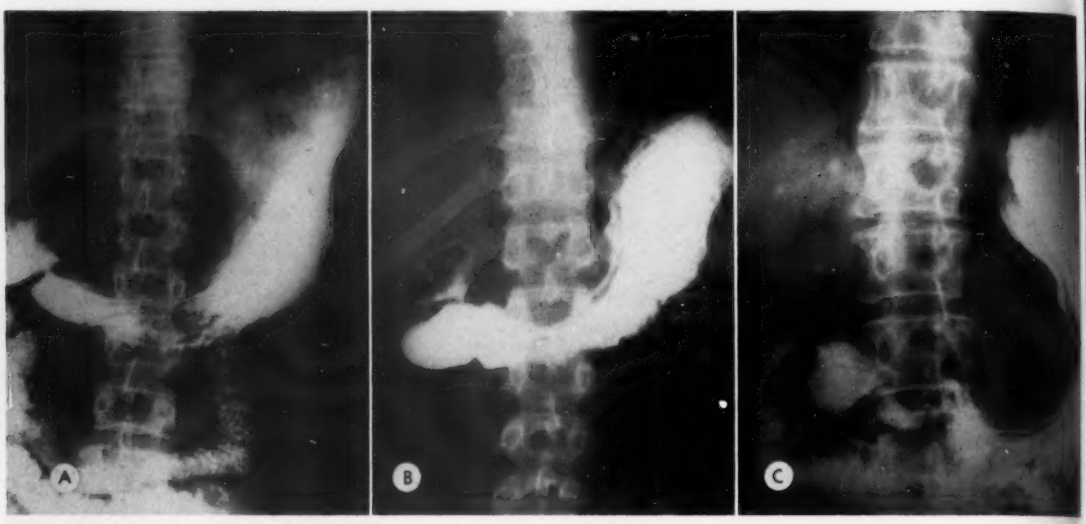

FIG. 2. (*A*) The "pad" sign is demonstrated in a case of hepatomegaly due to cirrhosis. (*B*) The "pad" sign in a case of carcinoma of the body of the pancreas. (*C*) This roentgenogram clearly shows the "pad" sign or defect along the lesser curvature associated with an enlarged kidney due to hydronephrosis.

3, *A* and *B* the method of simultaneous opacification of the entire upper gastrointestinal tract is demonstrated. Here we see delineation of a space-occupying mass situated posteriorly in the right side of the abdomen, neither indenting nor displacing

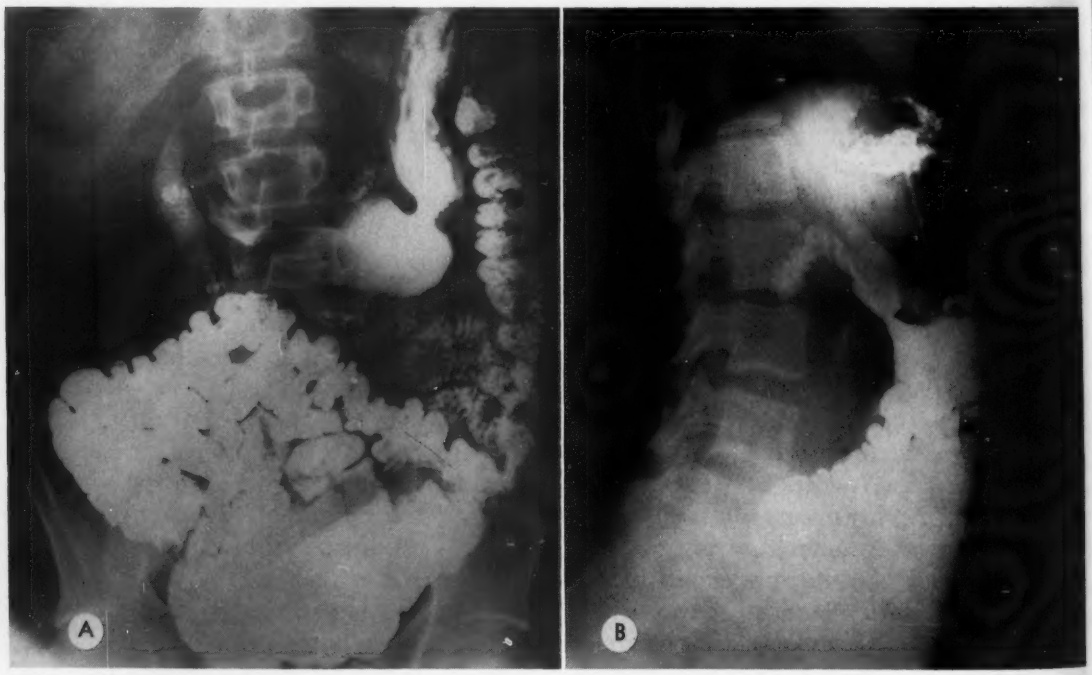

FIG. 3. (*A*) Simultaneous opacification of stomach, small bowel, colon and gallbladder shows slight downward displacement of the right half of the colon and small intestine with no indentation or displacement of gallbladder, duodenum or stomach. Findings suggest mass in the right upper quadrant of abdomen. (*B*) Same case in the lateral view with considerable forward displacement of colon and small intestine by space-occupying mass lying in area of right kidney. Cyst of kidney cortex found surgically.

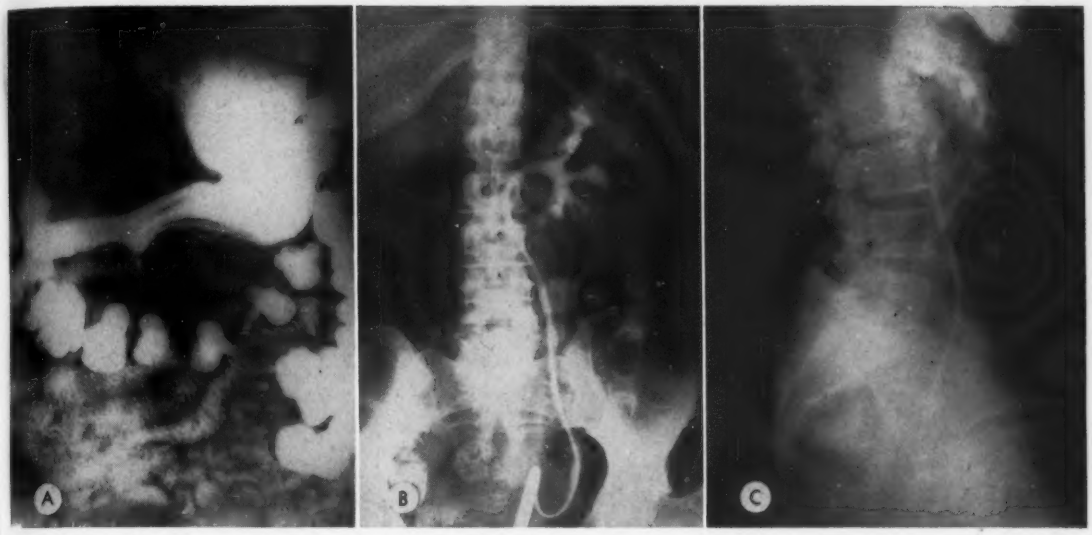

Fig. 4. (*A*) A roentgenogram demonstrating a large pancreatic mass impinging on the greater curvature of the distal half of the stomach (cyst of the body of the pancreas). (*B*) Same patient after left retrograde pyelography with medial displacement of the upper ureter. (*C*) Lateral view on same patient after left retrograde pyelography with simultaneous opacification of the stomach. A space occupying mass is seen between the superoanterior surface of the kidney and the posterior wall of the stomach. The kidney itself is displaced forward by a large mass originating in the posterior aspect of the renal parenchyma and proving to be a renal cell carcinoma.

the descending duodenal segment or stomach. The small intestine and colon are displaced downward and forward. Although an intravenous pyelogram showed a normal collecting system, the obvious posterior location of the mass suggested its relationship to the kidney. A cyst of the right kidney cortex was found at operation.

The importance of right angle studies of the upper urinary tract has been emphasized. Normally, in lateral studies during pyelography, the kidney is seen to hug the vertebral column. Displacement of the collecting system of either upper urinary tract in a specific direction helps to identify the origin of a mass. Simultaneous right angle study of the opacified upper gastrointestinal tract with pyelography has not been stressed, although occasionally we have found this combined procedure to be of inestimable value.

The efficacy of this combined procedure is demonstrated in a patient with a clinically suspected pancreatic cyst. The combined opacification of the urinary tract and the upper gastrointestinal tract permitted the identification of an additional lesion in the kidney as well as the pancreatic cyst. Figure 4, *A*, *B* and *C* illustrates this case.

CLINICAL APPLICATIONS

Right angle roentgenograms of the abdomen with opacification of the upper gastrointestinal tract are of importance with reference to a number of organs and disease entities. In this presentation, we will omit any references to masses in the head of the pancreas—vaterian segment area. Such masses have a special significance and have been dealt with by Poppel and his associates.[3,4] Our material will concern itself with enlargement and/or masses of the liver, spleen, kidney and pancreas (body and tail). The subject of lymphomas and multiple tumors in the abdomen will be illustrated and a brief reference will be made to inflammatory and neoplastic changes in the stomach and duodenum, demonstrated by right angle roentgenography.

I. *Hepatic enlargement.* A. Liver enlargement in cirrhosis. Usually an enlarged

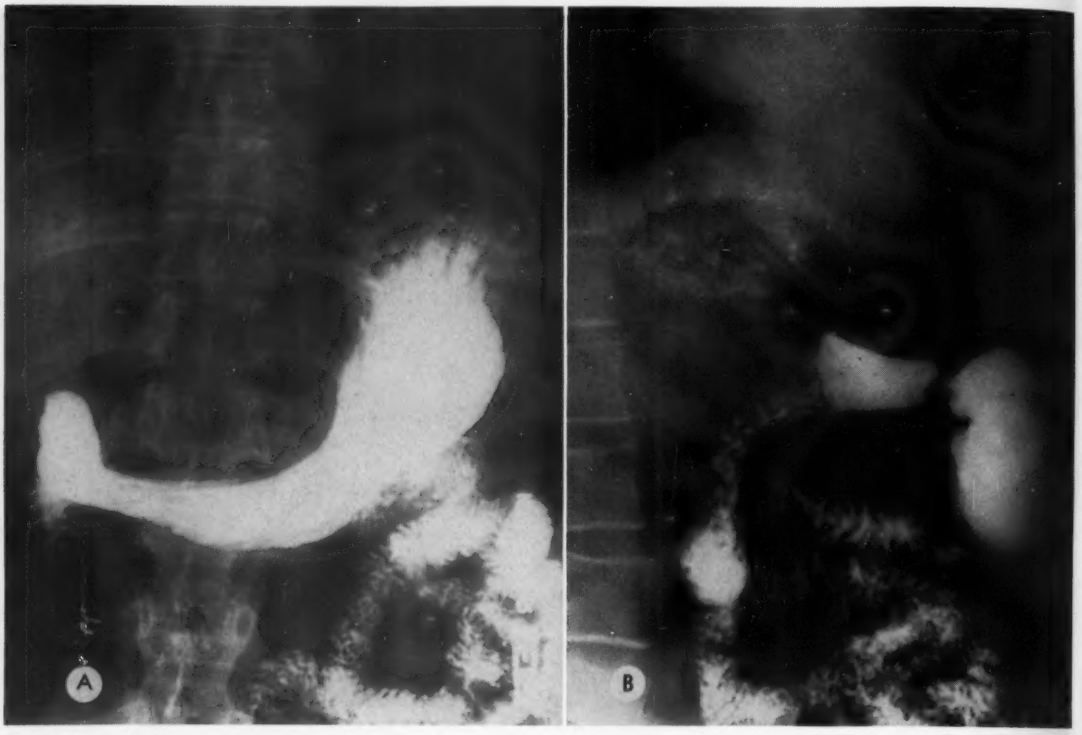

FIG. 5. (*A* and *B*) Frontal and lateral roentgenograms of an enlarged cirrhotic liver displacing the stomach forward. This displacement is clearly seen in the lateral view.

liver will displace the stomach posteriorly, with the liver mass encroaching itself upon the anterior gastric wall and lesser curvature. Occasionally, the liver insinuates itself posteriorly as it enlarges and displaces the stomach forward. Figure 5, *A* and *B* is an example of such a forward displacement of the stomach by an enlarged cirrhotic liver.

B. Hepatoma. Enlargement of the liver

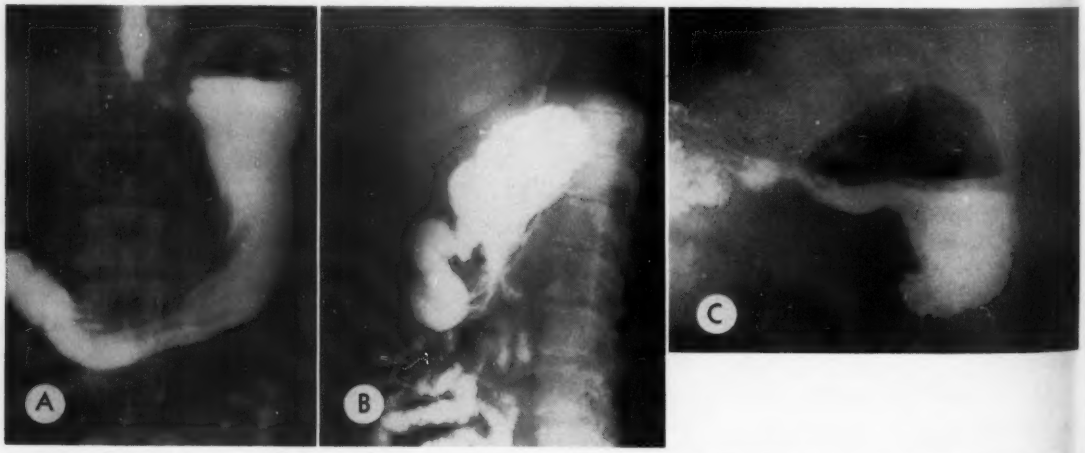

FIG. 6. (*A*) In the frontal plane, an erect roentgenogram shows an indentation on the mid-portion of the stomach, particularly on the lesser curvature aspect. (*B*) Right lateral recumbent roentgenogram with the liver indenting anterior surface of the distal half of the stomach and displacing it backward. (*C*) Transsupine lateral decubitus roentgenogram showing a large indenting mass on the anterior aspect of the distal half of the stomach due to the hepatoma.

by an hepatomatous mass may be best demonstrated in right angle roentgenography. The stomach will be indented anteriorly and displaced backward by the mass, as noted in Figure 6, *A*, *B* and *C*.

II. *Splenic enlargement.* Right angle roentgenography of the barium-filled stomach constitutes a valuable method of determining the presence and extent of splenic enlargement. The spleen enlarges posteriorly, as well as inferiorly, with the posterior enlargement taking place quite early. The stomach is generally indented on its posterior aspect and displaced forward. Figure 7 represents an example of an enlarged spleen, encroaching on the posterior wall of the stomach.

III. *Kidney enlargement.* There are various causes for kidney enlargement, such as collecting system ectasia, cysts and tumor masses. Early signs of such enlargement may be detected by right angle roentgenography with particular reference to the opacified descending duodenum. The kidney mass will displace the descending duodenal segment forward, indenting the posterior duodenal wall.

A. Collecting system ectasia. Dilatation of the collecting system sufficient to enlarge the kidney, will cause early forward displacement of the descending duodenal loop. If the enlargement is sufficient, the stomach may be indented (Fig. 2*C*).

B. Cysts. A renal cyst acts as a space-occupying mass and will indent the descending duodenum and displace it forward. Occasionally, if the cyst is sufficiently large, segments of the small bowel and colon may be displaced forward, as seen in right angle roentgenography. Figure 3, *A* and *B* shows a cyst of the kidney displacing the intestinal loops anteriorly and downward.

C. Tumor. A neoplasm of the kidney will act much the same as a cyst with forward displacement of the descending duodenal segment and localized indentation (Fig. 8). Pararenal tumors, such as neuroblastomas, may displace bowel loops as well as the stomach. An example is noted in Figure 9, *A*, *B* and *C*.

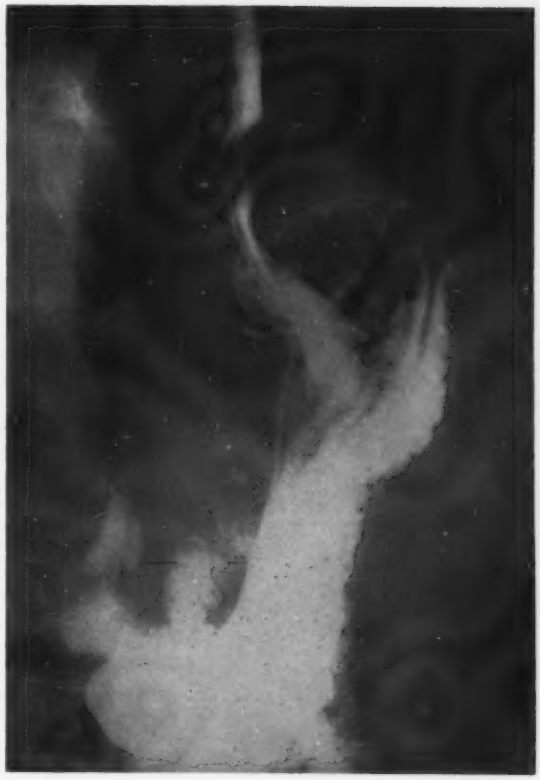

Fig. 7. Right anterior oblique roentgenogram showing an indentation on the posterior aspect of the fundus of the stomach due to an enlarged spleen.

Although we are not advocating the diagnosis of kidney masses by routine examination of the upper gastrointestinal tract, occasionally a small kidney mass will be detected early in right angle views, especially when the patient's complaints are not urinary but gastrointestinal in nature (Fig. 8). The accurate evaluation of the right angle films of the opacified stomach and duodenum may, at times, help clarify obscure findings noted on pyelography.

IV. *Pancreatic enlargement.* Reference to the head of the pancreas—vaterian segment—is omitted, as stated above. The discussion is limited to enlargement of the body and tail of the pancreas.

A. Body of the pancreas. (1) Tumor. Neoplasms of the body of the pancreas are notoriously difficult to diagnose. All of us have experienced cases which have gone un-

Fig. 8. This patient complained only of upper gastrointestinal tract symptoms. The right lateral recumbent roentgenogram of the opacified stomach and duodenum shows forward displacement and indentation of the posterior wall of the descending duodenal segment, indicating a kidney mass. A renal cell carcinoma was found at operation.

diagnosed and were discovered only at autopsy. Even with right angle roentgenography, small lesions of the body of the pancreas may be undetectable within the limits of our present knowledge of this modality. However, an adequately performed gastrointestinal tract examination is the most effective method of arriving at a diagnosis, short of exploration. A lesion in the body of the pancreas, if large enough, will intrude itself on the posterior gastric wall, indent this wall and displace the stomach forward. Figure 10 is an example of a carcinoma of the body of the pancreas acting in this manner. The "pad" sign may be seen in relatively early lesions (Fig. 2*B*). (2) Cyst and pseudocysts of the body of the pancreas. These lesions act like neoplasms, producing a localized indenting and displacing effect on the barium-filled stomach. Fig. 11, *A*, *B* and *C* represents a pseudocyst of the body of the pancreas follow-

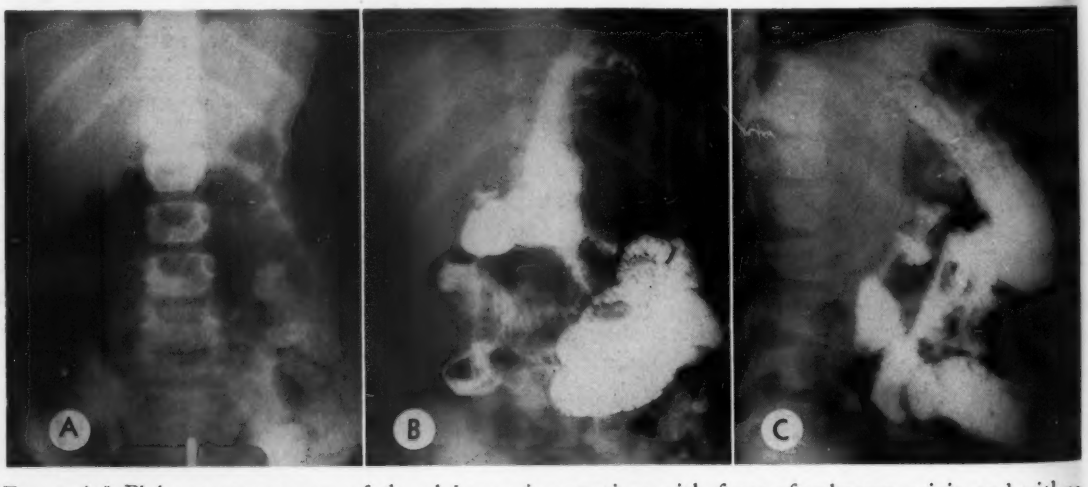

Fig. 9. (*A*) Plain roentgenogram of the abdomen in a patient with fever of unknown origin and with no clinically demonstrable mass. Note the faint calcifications in the left upper quadrant and the narrowed streaking of gas in the displaced stomach. (*B*) Same patient with the stomach displaced medially. (*C*) Right lateral recumbent roentgenogram of the same patient with the upper portion of the descending duodenum displaced forward and "on stretch." The stomach is also displaced forward. A retrograde pyelogram showed lateral displacement of the upper ureter. A diagnosis of suprarenal tumor mass was made preoperatively and a neuroblastoma was found at surgery.

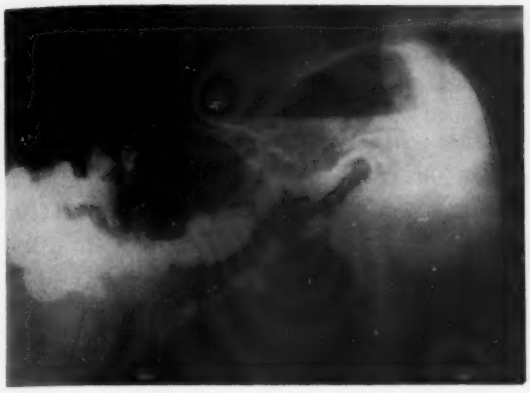

Fig. 10. A supine translateral roentgenogram showing an indentation on the posterior aspect of the fundus of the stomach. At operation a carcinoma of the body of the pancreas was found.

ing pancreatitis, with indentation and forward displacement of the stomach.

B. Tail of the pancreas. Lesions of the tail of the pancreas, either cysts or tumors, may be difficult to diagnose, particularly in the early stages. Because of contiguity with the left kidney, lesions of the tail of the pancreas may displace the kidney downward and sometimes medially. However, forward displacement of the barium filled stomach with indentation of the posterior gastric wall may be the earliest sign of the presence of a mass in the pancreatic tail. Figure 12 represents an example.

V. *Lymphomas.* Retroperitoneal lymphomas, as well as other retroperitoneal tumors, are frequently best seen in right angle studies of the upper gastrointestinal tract. Lymphomas may present minimal signs in the conventional plain roentgenograms of the abdomen or standard exposures of the retrogastric space. In this connection apparently normal right and left retrogastric spaces, in the standard lateral studies, do not exclude a midline mass. The supine translateral exposure may then become of great importance in such instances. Figure 13 is an example in point.

VI. *Multiple tumors.* Multiple intra-abdominal tumors, although rare, do occur. Simultaneous opacification of the upper gastrointestinal tract and the upper urinary tract in the frontal and lateral views may

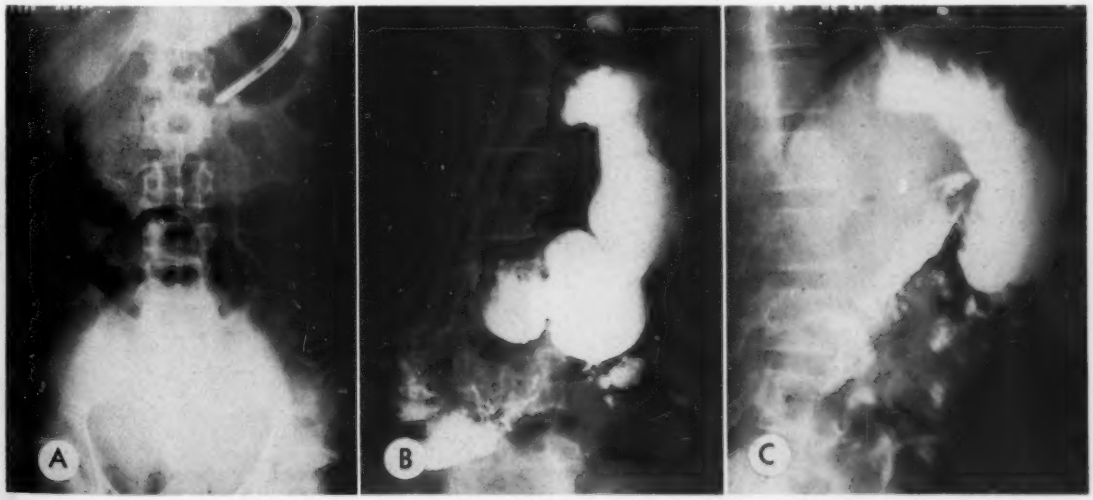

Fig. 11. (*A*) Plain roentgenogram of the abdomen showing a large soft tissue mass enlarging and displacing the descending duodenal loop and indenting the greater curvature of the distal half of the stomach. The mass is well circumscribed with gas in the stomach and all segments of the duodenum. (*B*) Frontal roentgenogram of the barium opacified stomach and duodenum with an indentation seen on the outer and upper wall of the proximal portion of the descending duodenum. There is considerable irregularity and thickening of the adjacent duodenal mucosa. There is widening of the duodenal loop. (*C*) Right lateral recumbent roentgenogram showing displacement of the stomach and upper portion of the descending duodenum forward with straightening of the descending duodenal segment. (A radiolucent area overlying the posterior soft tissues represents an artefact.) At operation, a pseudocyst of the head and body of the pancreas was found.

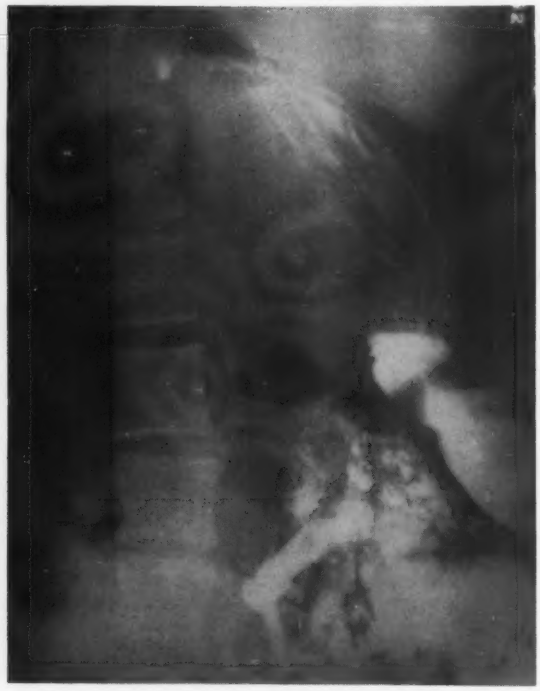

FIG. 12. The body of the stomach is indented on its posterior wall and displaced forward in this right lateral recumbent view. A carcinoma of the tail of the pancreas was found at operation.

provide an excellent method of studying adjacent histologically unrelated structures. Figure 4, *A*, *B* and *C* represents such a case of multiple tumors (pancreatic cyst and renal cell carcinoma).

VII. *Stomach and duodenum.* Although we are mainly concerned in this presentation with delineation of upper abdominal masses, right angle roentgenograms also play a prominent role in the accurate diagnosis of intrinsic lesions of the stomach and duodenum. Sometimes an ulcer niche is only identified in a right angle view. At times such views will differentiate a neoplastic from a benign ulcer. Thus, the intraluminal or extraluminal nature of an ulcer may be best appreciated in these views. Gastric ulcers of the posterior wall may be best demonstrated in this manner even though their presence may be suspected and an accurate diagnosis made in oblique and frontal plane projections (Fig. 14).

Extrinsic lesions invading the stomach may sometimes be seen best in right angle views. Figure 15 represents a carcinoma of the splenic flexure invading the posterior aspect of the stomach, with the lesion best seen in the lateral projection.

FIG. 13. A supine translateral roentgenogram in a patient with a dense third vertebral body, with no other clinical indication of lymphoma. All other roentgenograms, including right lateral recumbent, left lateral upright and standard projections failed to demonstrate any abnormality. In this translateral supine view there is shelving on the posterior aspect of the fundus of the stomach, with forward displacement of the stomach, indicating a retroperitoneal mass. At operation, a lymphoma (Hodgkin's) was found.

FIG. 14. A large extraluminal ulcer is seen on the posterior wall of the fundus of the stomach. The extraluminal appearance of the ulcer was only appreciated in the single right lateral roentgenogram. The diagnosis of benign gastric ulcer was confirmed at operation.

Intrinsic Lesions of the Proximal Duodenum. Bulbar ulcers. The diagnosis of duodenal bulbar ulcers may generally be made by fluoroscopy, spot roentgenography and oblique and frontal plane roentgenography, but the efficacy of right angle roentgenography in detecting such ulcers is not fully appreciated. Figure 16 represents such an instance, when only the supine translateral roentgenogram showed several small duodenal ulcers in a patient examined as an emergency case because of massive bleeding. The two small ulcer niches were not demonstrated in any of the other projections.

Postbulbar ulcers. Here again the utilization of right angle roentgenography may be helpful in either noting for the first time or confirming the presence of a postbulbar duodenal ulcer. Figure 17 is an example of a postbulbar ulcer, best demonstrated in the right lateral view.

Fig. 16. Supine translateral roentgenogram showing two small flecks of barium in the area of the duodenal bulb, seen in a patient examined as an emergency case for massive gastrointestinal bleeding. The small flecks were not seen in any other view and on operation the flecks corresponded to two small ulcer craters in the duodenal bulb.

SUMMARY AND CONCLUSIONS

1. The importance of right angle roentgenography of the upper gastrointestinal tract is emphasized in the diagnosis of such entities as liver enlargement, splenic en-

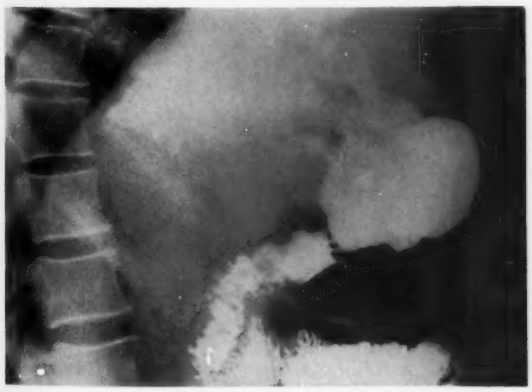

Fig. 15. Right lateral recumbent roentgenogram of the barium filled stomach and duodenum with evidence of irregular destruction of the mucosa of the fundus of the stomach and indentation of the posterior wall by a large mass. At operation a carcinoma of the splenic flexure involving the posterior wall of the stomach was found.

Fig. 17. Right lateral roentgenogram of the barium filled stomach and duodenum showing a postbulbar duodenal ulcer, best demonstrated in this view.

largement, neoplasms and cysts in the body and tail of the pancreas, renal collecting system ectasia, cysts and tumors of the kidney, gastric ulceration and neoplasm, extrinsic lesions of the stomach and duodenal bulbar and postbulbar ulcers.

2. Plain roentgenograms of the abdomen in right angle projections may at times clearly identify intra-abdominal masses by careful study of the normal anatomic structures with specific reference to the gas shadows.

3. Right angle roentgenography of the upper urinary tract in conjunction with simultaneous opacification of the upper gastrointestinal tract may be important in the analysis of obscure intra-abdominal solitary and multiple masses.

4. The importance of the supine translateral roentgenogram of the barium filled stomach and duodenum is re-emphasized, indicating that this view may be the only one that demonstrates a mid-line lesion.

5. The problems of retrogastric measurements are discussed, emphasizing that extrinsic pressure defects with indentation of the barium filled stomach and duodenum are of great importance in arriving at a definitive diagnosis.

6. The "pad" type of defect on the lesser curvature surface of the stomach is discussed in the diagnosis of high epigastric masses.

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VOL. 80, NO. 6

BILIARY TRACT ROENTGENOGRAPHY IN LATERAL DECUBITUS POSITION*

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WHILE presenting an exhibit relating to intraluminal lesions of the gallbladder[1] during the recent convention of the American Roentgen Ray Society, it became obvious that relatively few radiologists are employing the lateral decubitus position in examination of the biliary tract. This observation was made evident by inquiries of visitors as to the technique of the cholecystograms demonstrated at this exhibit. It was the impression that some radiologists, but still relatively few, were employing the technique of upright spot roentgenography of the gallbladder either as a primary procedure or in conjunction with the older method of examination in the supine or prone position. Since a sufficient number expressed interest in our method, we would like to publish our experience and technique for general appraisal.

The technique is not original with us. Whelan[4] demonstrated stratification of gallstones by this means in 1951. Mullen and Makielski[2] described their method in 1952 but the advantages have never been widely recognized, nor has the decubitus position been much utilized except as the occasional adjunct to a problem case.

In the years past we used the older, conventional prone or supine method of cholecystography with and without supplemental fluoroscopically controlled spot roentgenography. These procedures were disappointing for the following reasons:

1. A satisfactory examination frequently required considerably more than two, and sometimes as many as half a dozen separate exposures.
2. The supine examination was not adequate to exclude small stones because of the inability to "layer" them in the dependent position.
3. Gas or feces in the colon frequently obscured a portion or all of the gallbladder in either the prone or upright procedure. The use of pitressin to rid this gas was not only hazardous in older patients, but also time consuming.
4. The upright examination when done by a series of spot roentgenograms in various degrees of obliquity, usually entailed more exposures than are desirable.
5. Detail in the upright position was not as satisfactory because of distortion from short focal film distance and because of motion due to the lack of immobilization of the patient by proper restraining bands. This position allows the sagging abdomen in relaxed elderly patients to obscure the gallbladder detail even further. The compression device itself is not sufficient to immobilize the patient against the roentgenographic table, nor does it compensate for the increased tissue bulk imposed by gravity.

These criticisms apply to the best spot roentgenographic devices and rotating anode tubes.

The ideal cholecystogram requires primarily absence of motion, absence of superimposed bowel, a homogeneous background and ability of specific gravity to affect the gallbladder content. Visualization of the common duct should be present in 50 per cent of post-cholegogue films. Any technique which can satisfy these requirements should be recognized as the procedure of choice. Experience has shown that cholecystography done in the lateral decubitus position accomplishes this objective. As a sequel of this method, it has been the

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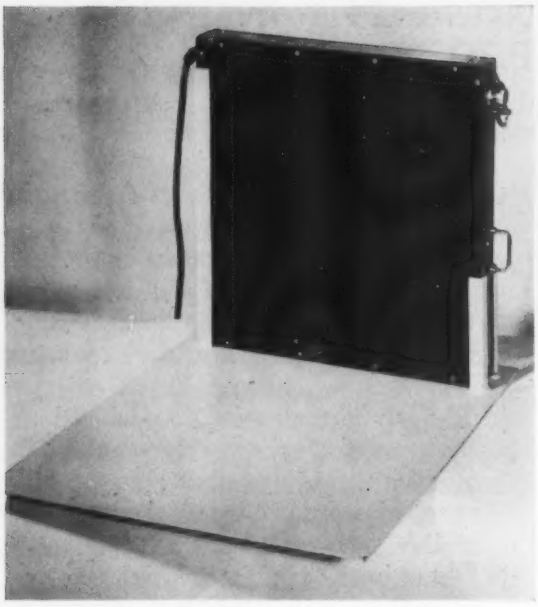

FIG. 1. Movable grid and supporting stand.

policy in our department to perform intravenous cholangiography in the same position with equally gratifying results.

EQUIPMENT

The equipment is simple. A conventional portable movable grid is employed. It is manually cocked, but synchronously tripped at the time of exposure. This grid is held in the vertical position by a convenient steel plated receptacle that is easily portable and is placed on the roentgenographic table top (Fig. 1). In order to elevate the patient from the table top and more properly center with the film in the Bucky tray, a 4-inch plywood cushion with 1 inch cover of foam rubber and plastic is added to the table top (Fig. 2 and 3). Actually, two cushions measuring 20 by 46 inches and 30 by 30 inches respectively are utilized. The more caudad cushion is wider and allows for flexing the thighs past the edge of the table top. The two cushions are locked together by simple hasps. Ten by twelve inch cassettes with par speed screens are employed.

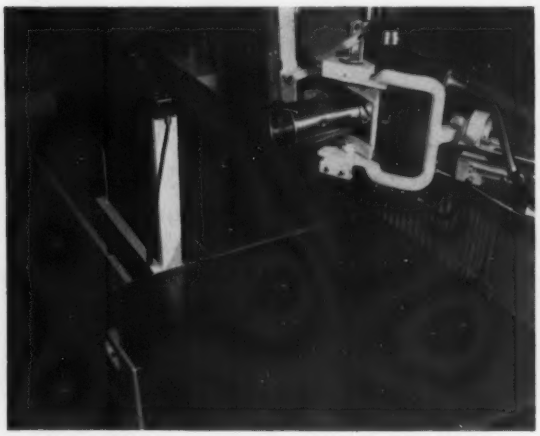

FIG. 2. Position and relationship of cushions and upright grid to roentgenographic table top.

FIG. 3. Position of patient on supporting cushions.

FIG. 4. The decubitus position allows good visualization of biliary tree in post-cholegogue films.

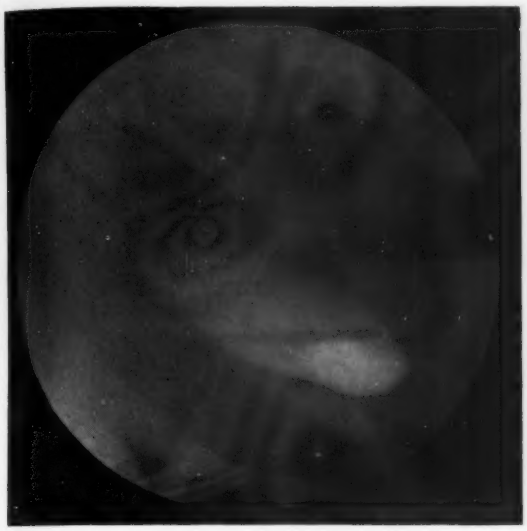

Fig. 5. Layered multiple small stones.

METHOD

It is not within the scope of this paper to consider the relative value of the different contrast iodinated compounds nor to discuss methods of preparation or use of various cholegogues.[3] The procedure of the examination is as follows:

1. The patient is placed on the roentgenographic table right side dependent, knees flexed, abdomen close to the upright grid container, the table equipped as illustrated with firm plywood cushion.

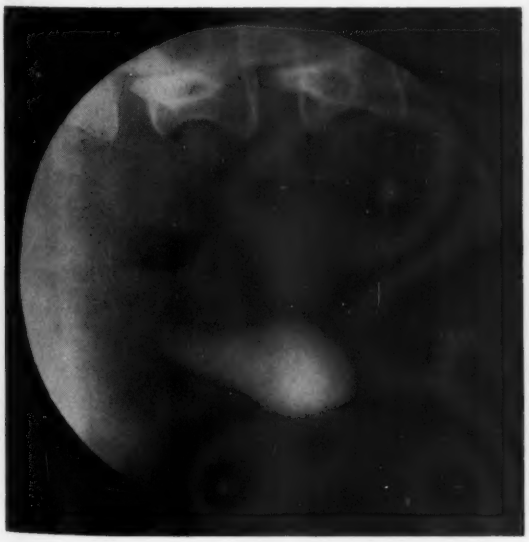

Fig. 6. Several small dependent stones.

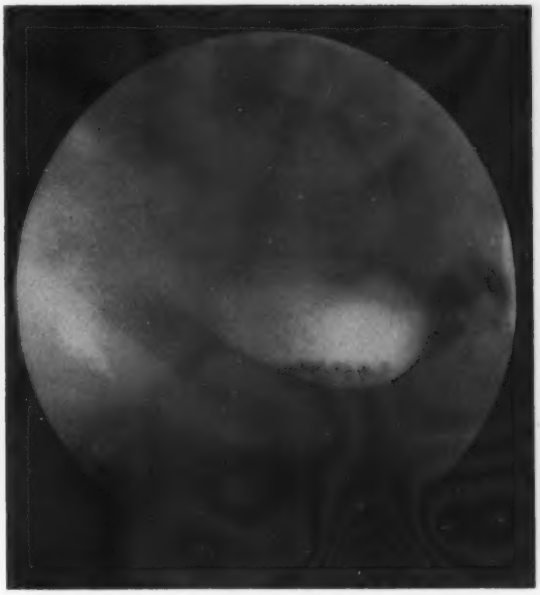

Fig. 7. Dependent mixed stones. Note position of hepatic flexure of colon.

2. A cone is utilized centering immediately below the last palpable rib on the right side.
3. The distance employed is 30 inches (Fig. 3).
4. Factors are .2 to .3 of a second at 300

Fig. 8. Cholecystogram in prone position performed elsewhere and interpreted as "normal."

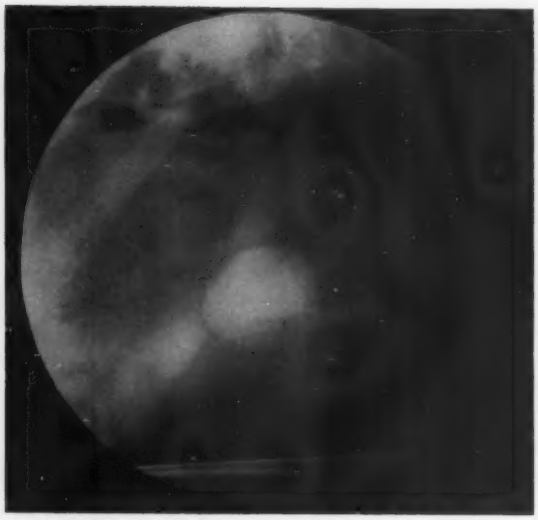

FIG. 9. Same patient as Figure 8. Multiple small nonopaque stones layered in dependent position.

ma., 75 kv. for the average 20 cm. patient.

5. Exposure is made *in full expiration.*
6. The patient is allowed to return to dressing cubicle and is fed a cholegogue.
7. The first film is processed and viewed "wet" by a radiologist and technician together. Any variation in technique or position is discussed. In a busy department four or five examinations are usually viewed simultaneously.
8. The second and usually final film is exposed. Only an occasional upright projection is employed with spot roentgenography and compression if it would add more to the information already derived.

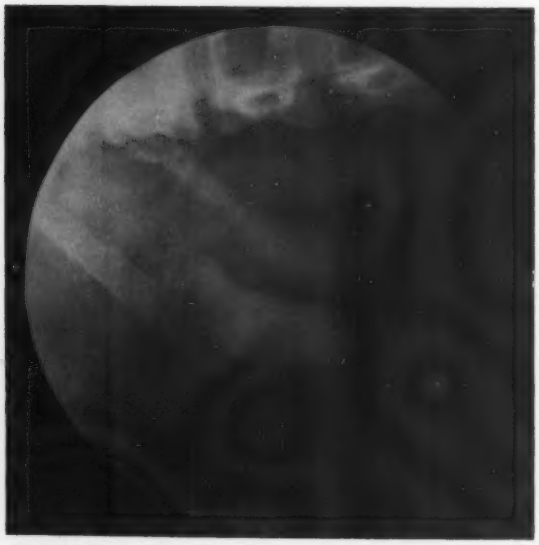

FIG. 10. Multiple cholesterol polyps can be easily distinguished from small nonopaque stones. The polyps maintain their position. Such is also true for papillomas, adenomas and inflammatory polyps.

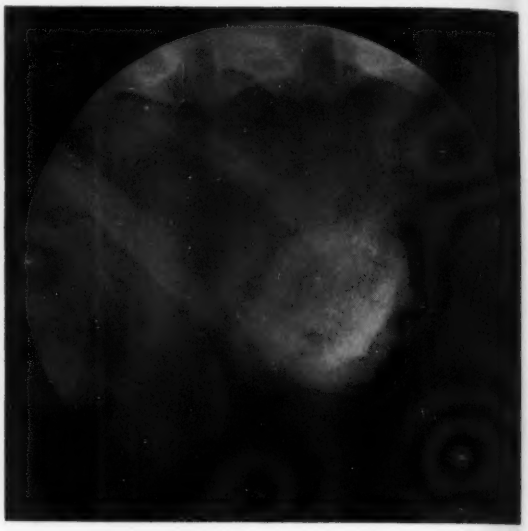

FIG. 11. Retained telepaque in stomach with outlet obstruction—resulting in nonvisualized gallbladder.

The advantages of this procedure are: 1. Fewer exposures are required than by other methods. The average number of films per patient examination for cholecystography is 2.2 in this Department. Exposure of gonads is therefore mimimal. 2. The liver offers a homogeneous background for the superimposed gallbladder without confusing shadows or gas or feces in the colon (Fig. 4). 3. When small stones or sand are present, "layering" is demonstrated (Fig. 5, 6, 7, 8, and 9). 4. Small stones when present can be readily visualized and differentiated from intraluminal tumors of the gallbladder, such as cholesterol polyps, adenomatous polyps, papillomas, inflammatory polyps and myo-epithelial anomalies of the fundus (Fig. 10). 5. When nonvisualization is a result of gastric outlet obstruction, the contrast material is seen in the pyloric antrum in the dependent

position, thus indicating that failure of visualization may not be on the basis of biliary tract disease (Fig. 11). 6. The number of re-examinations is reduced to a minimum.

Other than slightly more difficulty in the positioning of the patient, this method has no disadvantages.

CONCLUSION

Because of the continuing emphasis in reducing unnecessary roentgenographic exposure in diagnostic procedures, it seems important that any method that can accomplish this result should be more universally used. Lateral decubitus cholecystography not only accomplishes this purpose, but offers the advantage of more detailed, precise diagnostic cholecystography.

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ROENTGENOGRAPHIC STUDY OF CONGENITAL CHOLEDOCHAL CYSTS*

PRE- AND POSTOPERATIVE ANALYSIS OF FIVE CASES

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SINCE the use of intravenous opaque media, knowledge of previously obscure lesions is becoming more elucidated. Congenital choledochal cysts have in the past seldom been diagnosed correctly preoperatively.[21] It is our purpose to cite the roentgenographic findings and attempt to formulate criteria for more accurate diagnosis. This should aid the radiologist in his prognosis, thereby lessening the surgeon's confusion. Many times the cystic dilatation is found unannounced at exploration and surgical extirpation is attempted with a high mortality rate. That the lesion can be manifested at any age enhances the value of the present study.

The earliest references to congenital choledochal cyst are by Vater,[25] 1723, and Todd, 1818.[24] Since then there have been several comprehensive reviews,[1,21,31] but only one paper with reference to roentgenographic diagnosis.[28] The 5 cases reported here, added to those previously reported, bring the total of 247.[9] The most reasonable origin of these cysts is congenital. Yotuyanagi,[30] Gross,[8] Caroli and Marcoulides,[6] and Horne[9] have made contributions to the understanding of the pathogenesis. Accessory hepatic duct, double common ducts, double normal gallbladders, total agenesis of the bile ducts, and malignant degeneration of the cyst have rarely been associated.[2,14,17,23,27] Calculi can occur in the cyst[11] and trauma may cause rupture.[3,5] None of these complicating factors was seen in our material.

The entity occurs four times as frequently in females as in males. All of our patients were females, ranging in age from six and one-half months to thirty-six years (Table 1). In the literature an unborn fetus and a sixty-two year old woman are cited.[7,11]

Gross[8] mentioned that 35 per cent are manifest within the first ten years of life. The outstanding clinical features are abdominal pain (60 per cent), tumor (80 per cent), and jaundice (70 per cent). The triad is present in 60 per cent of the cases.[1,21] Pancreatic, mesenteric, hepatic or retroperitoneal cysts are most often considered clinically in the diagnosis. Exploration with aspiration of bile can lead to the correct diagnosis. The over-all mortality in the review of Shallow *et al.*,[21] regardless of treatment, was 58 per cent. Gross reports a mortality of 69 per cent in children. However, with primary anastomosis of the biliary tract and intestines, the mortality was only 9 per cent. Gross advocated choledochoduodenostomy. Because of the possibility of aspiration and cholangitis, many surgeons have used the Roux en Y anastomosis.[1,15] All of our 5 cases finally had such a procedure. Three had multiple operations (see Table 1).

REPORT OF CASES

CASE 1. B.L., a six and one-half month old white female, entered this hospital on March 2, 1949. Her local physician noted a mass in the upper right abdomen when she was three months old. She had gained weight steadily, and the mass became larger. The patient had received blood transfusions during the first days of her life. The mother was Rh negative and the father Rh positive.

The abdomen appeared slightly distended. Below the liver edge was felt a smooth and firm mass, which extended toward the midline. Its edge was about at the umbilicus.

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Presented at the Annual Meeting of the Association of University Radiologists, University of Minnesota, May 19, 1957.

TABLE I

SUMMARY OF CLINICAL MATERIAL

Pt.	Age Sex	Clinical Triad			Preoperative Diagnosis	Roentgenologic Features	Surgical Treatment	Remarks
		Mass	Icterus	Pain				
B.L.	6½ mo. F	2+	−	− +	Retroperitoneal tumor	Nonvisualized gallbladder. Soft tissue mass. Duodenal impression	Roux-Y anastomosis 1949. Gallbladder anastomosed to arm of jejunum 1951	1957. Progress good. Occasional stomach ache of a colic-like nature
B.S.	8½ yr. F	1+	−	+	Choledochal cyst	Gallbladder visualized with mass. Duodenal impression. Intravenous cholangiogram diagnostic	Exploration September, 1955. Roux-Y anastomosis April, 1956	Eight months postoperatively doing well. Two febrile episodes since leaving hospital
C.E.	10 yr. F	1+	+	+	Pancreatic cyst	Studied in postoperative period with intravenous cholangiography. Dilated radicals	Choledochoduodenostomy 1945. Choledochojejunostomy (Roux-Y) 1947. Division of proximal limb 1957	Function studies of liver normal
K.P.	12 yr. F	4+	+	+	Primary liver disease clinically. Choledochal cyst roentgenologically	Nonvisualized gallbladder. Large soft tissue mass. Duodenal impression	Roux-Y anastomosis	Postoperatively, the cyst emptied in right oblique position. Six months postoperatively no complaints or findings
B.T.	36 yr. F	4+	−	2+	Pancreatic cyst. Hydrops of gallbladder. Echinococcus cyst	Nonvisualized gallbladder. Soft tissue mass. Widened duodenal loop	Explored 1945. Choledochal cyst. Jejunostomy and jejunojejunostomy 1946	Lost to follow-up. Immediate result good

Laboratory findings showed a white blood cell count of 14,800. Retrograde pyelographic study disclosed normal internal calyceal structures. Cholecystography failed to visualize a gallbladder. A soft tissue mass could be made out in the right upper quadrant, which was separate from the kidney and the liver.

March 25, 1949, exploration revealed a 4 by 5 inch mass, which was identified as a large cystic dilatation of the common duct. An anterior anastomosis was made between a loop of jejunum and the cyst. A second anastomosis was made about four inches from the stoma, between the two arms of the jejunum to shunt the food stream.

About October, 1950, she began to have attacks of colicky abdominal pain, chills, fever, and acholic stools. In January, 1951, jaundice and amber urine became associated with these complaints. The patient was re-admitted on March 16, 1951. Barium series revealed no reflux into the previously operated area. There was air in the region of the biliary tree. Liver function studies showed an elevated alkaline

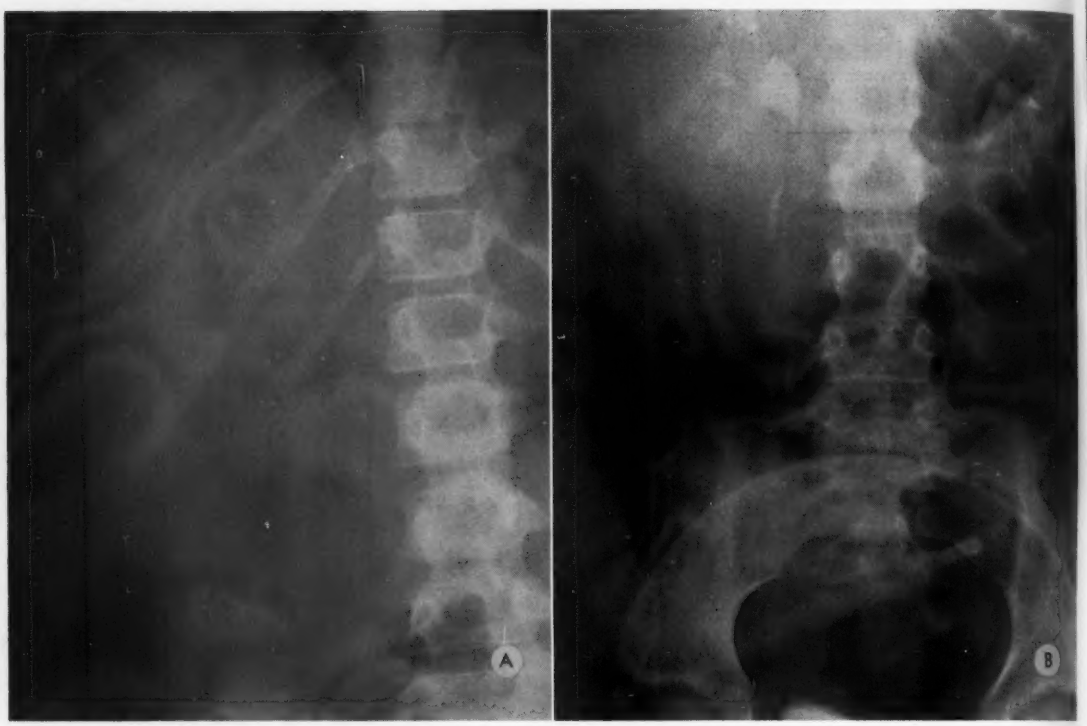

FIG. 1. Case IV. K. P. (*A*) Oblique roentgenogram of abdomen demonstrates three soft tissue densities: cyst, liver, and kidney. (*B*) An intravenous pyelogram shows an intact right kidney.

phosphatase—17.5 units. Bile was present in the stools and there was a trace of urobilinogen in the urine.

On March 28, 1951, the child was taken to surgery. Bile was present in the bowel, but the previously anastomosed site was scarred and the surgeons were unable to get a probe through the area. Only a remnant of the common duct was noted. The two severed ends of the proximal arm of the jejunum were turned in. The gallbladder was large and turbid bile was obtained from the gallbladder, as well as the dilated end of the common duct. The gallbladder was anastomosed to the descending arm of the jejunum. The patient left the hospital on April 5, 1951.

Correspondence on January 11, 1957 related that the young girl is progressing well. Occasionally, she complains of stomach ache of a colic-like nature. She tends to eat smaller amounts of food and at more frequent intervals.

CASE II. B.S., an eight and one-half year old white girl, had intermittent abdominal pain associated with fever, nausea, and vomiting for a period of eighteen months. In September, 1955, she was explored elsewhere and it was thought that she had a pancreatic cyst. She drained postoperatively, but the abdominal fistula healed spontaneously. She again had pain, vomiting and fever. It was commented that she appeared icteric during these episodes. She entered the University of Illinois Hospitals on March 26, 1956.

Physical examination revealed the abdominal musculature to be flaccid with a long surgical incision in the right side. A fullness in the right upper quadrant was noted which seemed to vary in size from time to time, but was accepted to be due to a mass.

On March 29, 1956, an upper gastrointestinal barium study showed an impression on and displacement anteriorly of the first and second portion of the duodenum (Fig. 2*A*). An oral cholecystogram revealed double opacities with the more lateral density having the contour of a normally shaped gallbladder and the more medial and superior density approximately twice the size of the other (Fig. 3). The intravenous cholangiogram demonstrated, at the thirty minute interval, the marked cystic dilatation of the common duct; and at the two hour interval, a second shadow compatible with gallbladder filling (Fig. 4).

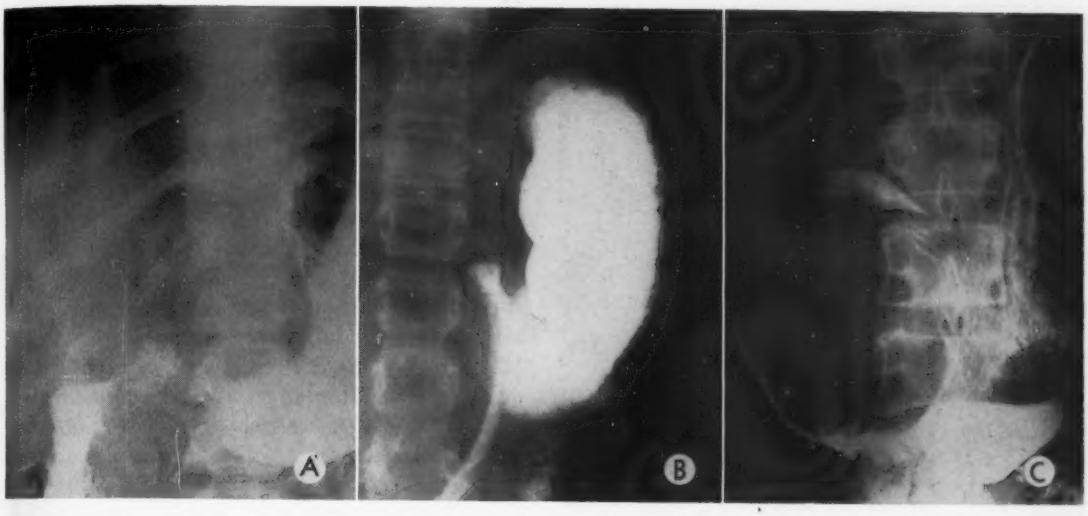

Fig. 2. (*A*, *B* and *C*) Various duodenal impressions to be expected according to capacity of cyst and location. Cases II, IV and V, respectively.

The patient was operated on April 16, 1956. The common duct was a cystic mass about 8 cm. in its greatest diameter. The gallbladder was thickened and was adherent to the abdominal wall, suggesting that the gallbladder had been drained previously. A Roux en Y arm was constructed about 1 foot from the ligament of Treitz and was anastomosed to the cystic common duct. Fluid aspirated from the cyst at the time of surgery, when analyzed for amylase, contained 51,000 units.

During the first week postoperatively, she had slight fever. She was last seen in the Clinic on January 7, 1957. She was gaining weight, but had experienced two febrile episodes since leaving the hospital.

Case III. C.E., a seventeen year old white female, was first admitted to the University of Illinois Research and Educational Hospitals in July, 1957. Prior to this she was explored twice elsewhere. A choledochal cyst was finally diag-

Table II

ROENTGENOLOGIC STUDY OF CONGENITAL CHOLEDOCHAL CYST

1. Plain Films	Right upper quadrant mass contiguous with liver and separate from kidney. Displacement of gas shadow of colon, duodenum or stomach. Postoperative period, air in remnant of cyst and biliary ducts
2. Oral Cholecystogram	Usually of no aid. Nonvisualization is frequent finding. Rarely gallbladder will be seen
3. Barium Meal	Duodenum usually displaced, anteriorly and to the left. May have widened loop. Postoperatively, reflux of barium can be demonstrated into cyst
4. Intravenous Cholecystogram	A. Diagnostic—if patient is seen when serum bilirubin levels are within normal ranges B. Value—assessing postoperative complaints
5. Introducing Contrast Substances through Aspirating Needle into Cyst[16]	Excretory urographic evidence that continuity between the cyst lumen and the gastrointestinal tract exists
6. Early Postoperative Cholangiogram through Surgical Tube	Determines satisfactory drainage of the biliary cyst through the enterostomy

FIG. 3. Case II. B. S. Oral cholecystogram demonstrates large medial mass and lateral inferior density. Dilated biliary radicals also present. See text.

nosed and it was reported that a choledochoduodenostomy was performed. Because of recurrent episodes of pain, jaundice, chills and fever she was reoperated on October 1, 1947. The previous stoma between the duodenum and choledochus cyst was found obliterated. A choledochojejunostomy using a Roux en Y arm of jejunum was made.

She was rehospitalized in April, 1951 for treatment of a urinary tract infection.

She was re-admitted in January, 1952 because of continued attacks of right upper quadrant pain. Urobilinogen was found in the urine on two occasions. Barium meal study showed air in the area of the anastomosis, and a reflux into the biliary tree was demonstrated (Fig. 6, *A* and *B*). The child showed no objective evidence of having any great difficulty and was discharged. In October, 1955, liver function profile tests were within normal limits and intravenous cholangiographic study revealed dilated biliary radicals. The study was repeated in September, 1956, and the findings were unchanged (Fig. 7).

She was again hospitalized in March, 1951, on the basis of recurrent symptoms, possibly being due to intermittent regurgitation of jejunal contents into the cyst and biliary tree. The patient was reoperated upon and the proximal limb of the choledochal-cyst-jejunostomy was divided and sutured near the site of the enteroenterostomy. She was discharged and when seen in the clinic a month later was doing well.

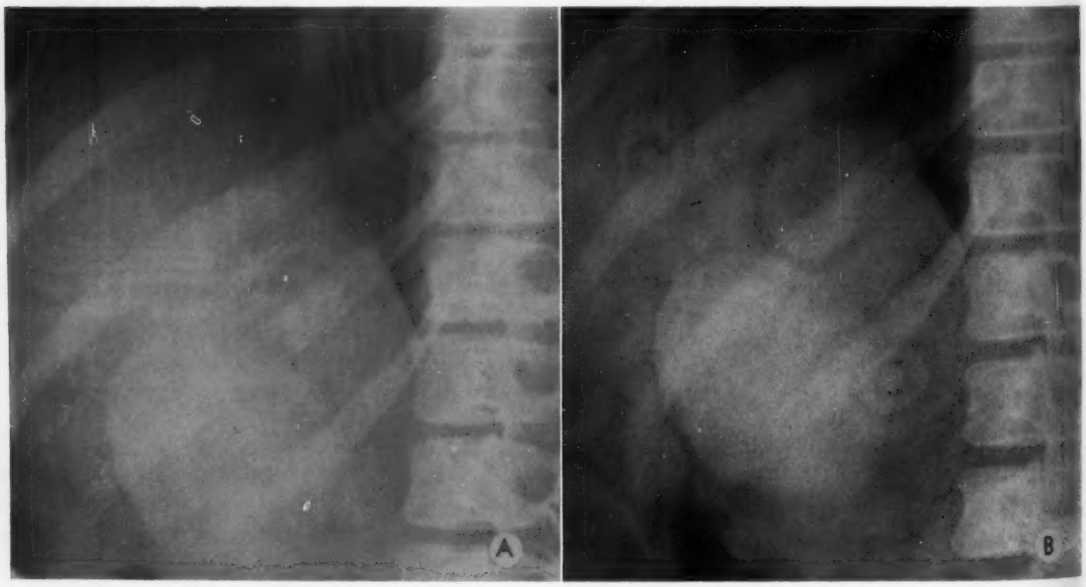

FIG. 4. Case II. B. S. (*A*) The thirty minute interval cholangiogram shows marked cystic dilatation of the common bile duct with the hepatic ducts mildly dilated. (*B*) The two hour cholangiogram reveals the more lateral and inferior shadow to be the normal gallbladder. The dilated hepatic ducts are more pronounced. (Both figures are intravenous cholografin studies prior to surgery and establishing correct preoperative diagnosis.)

Case iv. K.P., a twelve year old white female, was admitted to this hospital on July, 18, 1956. She had noted fatiguability, itching, and jaundice for one month. Discomfort and fullness was experienced in the right upper quadrant. Color of the stools had returned to normal, but the urine was dark at time of admission.

Physical examination revealed a jaundiced child in no acute distress. There was a mass in the right upper quadrant extending down to the umbilicus.

Laboratory studies showed normal hemograms, except for a sedimentation rate of 65 (normal 0–20). Urine revealed 2 plus bile. Alkaline phosphatase was 25.8 (normal 5–15). Other values were: cholesterol 506 (normal 130–230); thymol turbidity, cephalin flocculation and bone marrow culture were all negative.

On July 30, 1956, a liver biopsy showed marked portal fibrosis, bile stain and probable cirrhosis. Gallbladder series showed nonvisualization, and a large round soft tissue mass in the right upper abdomen was readily demonstrable (Fig. 1).

Since the liver biopsy was interpreted as more indicative of primary liver disease than extrahepatic obstruction, a one month's course of cortisone 100 mg./day was instituted. Serum bilirubin levels decreased from 17.4 mg. to 12.4 mg. shortly afterwards, but on September 5, 1956 the level was 23.2 mg. Roentgenograms showed the descending duodenum and gastric antrum displaced to the left by a large cystic appearing lesion (Fig. 2*B*). The colon was displaced downward by the large right upper quadrant mass. An intravenous pyelogram was normal. A choledochal cyst was presumptively diagnosed. A more careful examination of the upper abdomen by several consultants disclosed two masses, the liver with a distal edge and a rounded smooth mass projecting below and separate from the liver.

On exploration of the biliary tract, the liver was found enlarged, granular in appearance and deeply stained. There was a large, cystic mass occupying the area of the common duct which displaced the stomach, duodenum, and colon. The gallbladder was identified in the usual position, and was somewhat thick-walled and collapsed. About 1,000 cc. of bile were aspirated from the cyst. Palpation within the cyst revealed the right and left hepatic ducts as well as the cystic duct. The surgeon was unable to probe distally into the duodenum. An anastomosis between the collapsed cyst and the free end of the jejunal Roux en Y arm was made. An enteroenterostomy was also performed. Fluid from the cyst at the time of surgery contained no amylase and no bacteria were grown. Operative biopsies of the liver and the cyst wall revealed periportal fibrosis, chronic inflammatory cell infiltration, bile duct proliferation, and dilatation of the portal venous channels. In the central and mid-lobular region, bile canaliculi were plugged and distended with bile. These findings were consistent with biliary cirrhosis. A section of the cyst wall was composed of fibrous tissue in which few chronic inflammatory cells and vessels were seen. No epithelial lining was present.

On September 28, 1956, cholangiography via the catheter showed a large cyst filled with medium in the right upper quadrant of the abdomen (Fig. 5*A*). The cyst did not empty until the patient was placed in a semi-right lateral decubitus position (Fig. 5*B*). A standing film showed an air fluid level and an interphase between the contrast medium and fluid in the cyst (Fig. 5*C*). No reflux of contrast material was obtained into the intrahepatic biliary radicals, but some air was visible in the biliary tree. The postoperative bilirubin values were 27.0 mg. and 15.1 mg. The patient was discharged and two months later the bilirubin level was 0.71 mg. She was last seen early in 1957 with no complaints and no palpable abdominal findings.

Case v. B. T., a thirty-six year old white female, was admitted to the hospital on February 10, 1946. She had been operated on a month previously elsewhere and a pancreatic cyst was diagnosed. Her chief complaint had been epigastric distress with vomiting, which increased in severity over the last three months. Milder episodes were recalled during the previous ten years. Three months ago, she became aware of a mass in the upper abdomen, slightly to the right of the midline. Chills and sweating were experienced. Attacks occurred chiefly one to five hours after supper or any large meal. She had never been jaundiced.

Physical examination revealed a right paramedian incision in the upper abdomen and a smaller scar lateral to it. A large mass was palpable in the right upper abdomen, which was markedly tender, even to superficial palpation, jarring or percussion of the chest. A barium meal study demonstrated an enlarged, widened duodenal loop (Fig. 2*C*).

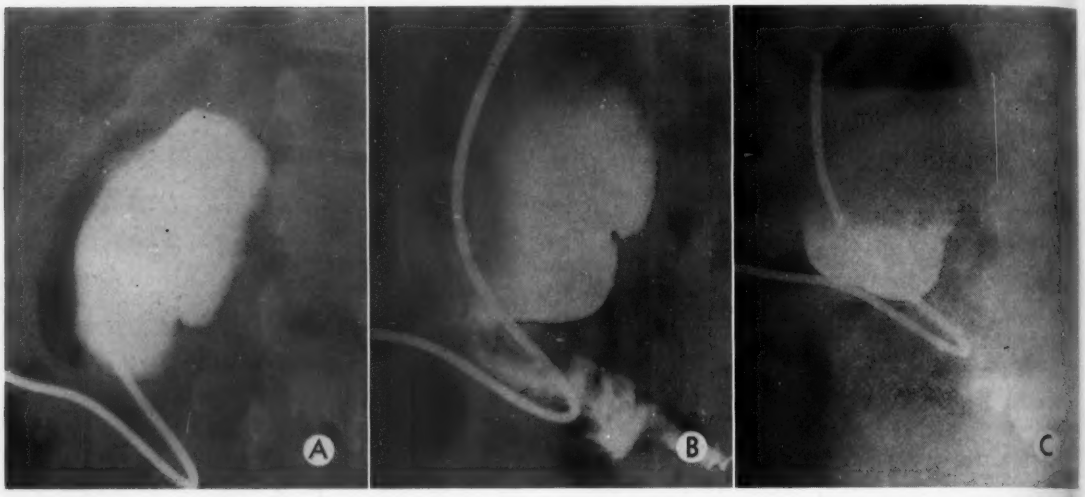

FIG. 5. Case IV. K.P. Postoperative injection via catheter demonstrates lack of emptying in the horizontal position (*A*), until the right lateral position is obtained (*B*). The standing film shows layering of the contrast material, with similar delay in emptying (*C*). Study following Roux en Y anastomosis.

The patient was reoperated and a fluctuating mass the size of a coconut was found under the pylorus, displacing the stomach forward and presenting through the gastrocolic omentum. The pancreas was flattened. The cyst was aspirated and dark turbid bile was obtained. Further exploration revealed that the cyst was actually arising from the terminal end of the common duct near the junction with the pancreatic duct but presumably proximal to that point. Thereupon, a choledocho-cyst-jejunostomy and jejunojejunostomy were performed. The proximal arm wall was folded with a double row of catgut, to isolate the anastomosis with the cyst wall from the food stream.

Fluid from the cyst revealed 454 units of amylase. Culture of the fluid demonstrated gram positive cocci which were identified as hemolytic Staphylococcus aureus. Microscopic study of the cyst wall revealed a mucosal covering which was thin, made up of a small amount of stroma infiltrated by round cells and a few polymorphonuclears. There was an intact, tall columnar epithelial covering and there were some crypts and folds. The rest of the wall was thick and included smooth muscle strands and was made up of fibrillar rather edematous connective tissue.

The patient was discharged as improved on March 9, 1946. The patient was lost to follow-up studies.

DISCUSSION

A preliminary study of the plain roentgenograms in the cases presented usually revealed a soft tissue mass density in the right upper quadrant. This varied in size according to the capacity of the cyst. Four cases had a mass density which was easily seen roentgenographically and palpable clinically. Case IV had a mass which fluctuated. On further scrutiny of the plain roentgenogram, the kidney and liver edge were noted, and the soft tissue shadow of the kidney could be seen to be separate from the mass (Fig. 1*A*). An intravenous pyelogram readily demonstrated an intact right kidney (Fig. 1*B*). Hydronephrosis of the right kidney due to pressure of the cyst was not noted in our cases and is an unusual finding in the literature.[28] The normal kidney on the right side eliminated that organ and also lessened the possibility of a retroperitoneal dermoid and a neurogenic tumor as the source of difficulty in differential diagnosis. With larger cysts, the hepatic flexure of the colon and the air shadow of the stomach are displaced.

When the barium meal is given, it is common to find that the duodenal loop is displaced inferiorly and to the left. Figure 2 shows the patterns of duodenal impression to be expected. Strnad[22] cited that dilatation of the common duct due to stones or tumor caused changes at the bulbar apex of the duodenum. Therefore, we should not

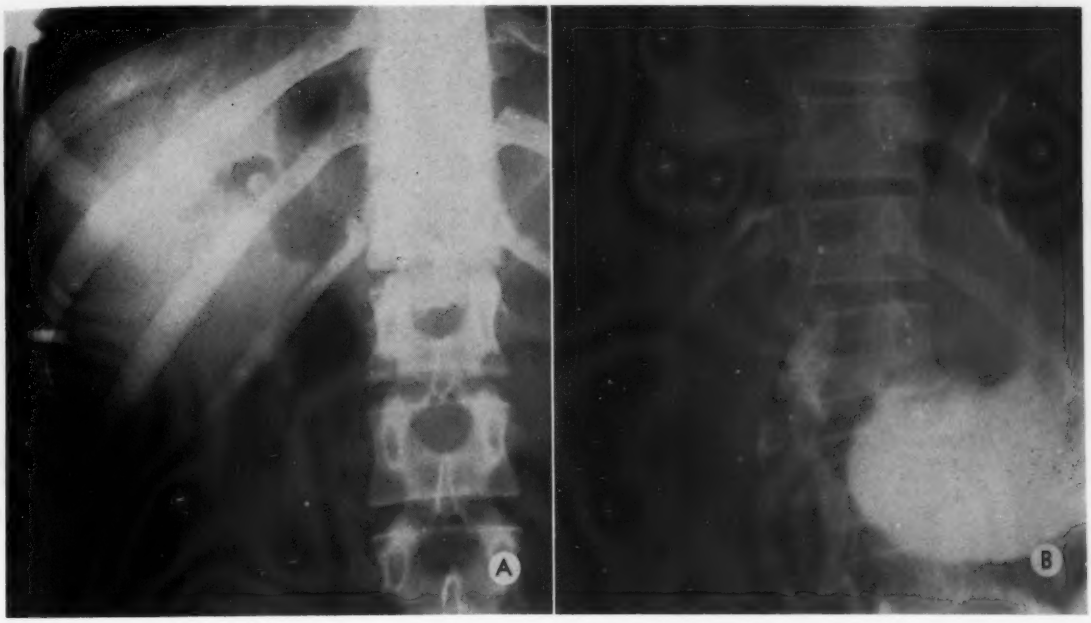

Fig. 6. Case III. C.E. (*A*) Air in limb of jejunum, cyst, and biliary radicals following choledochal-cyst-jejunostomy. (Roux en Y anastomosis eight years previously.) (*B*) Reflux of barium into cyst and biliary radicals during barium meal study. (Roux en Y anastomosis eight years previously.)

expect dilatation of the common bile duct due to stones or neoplasm to produce the large impressions and deviation of the duodenum as in Figure 2. Cysts have been reported in volume from 30 ml. to over 8 liters.[10,21] Varying with the size of the cyst and its location near the middle or terminal portion of the common duct, the duodenal impressions are readily understandable.

Oral cholecystographic study usually fails to demonstrate a gallbladder shadow in these instances. Four of our cases showed no concentration of contrast medium and this is a frequent finding in the literature. Many times the patient is seen when jaundiced and the serum bilirubin is elevated. Thus satisfactory concentration of the contrast medium cannot be obtained. When the cysts are large, they cause mechanical distortion and blockage of the cystic duct. These two factors account for the high percentage of nonvisualized gallbladders in our series and in the literature. Rheinlander and Bowens[19] reported cystic dilatation of the common bile duct associated with congenital absence of the gallbladder. In Case II, the oral cholecystogram revealed a confusing shadow (Fig. 3). The large medial mass was filled at the same time that the more lateral inferior shadow was seen. Several examiners suggested the diagnosis of duplication of the gallbladder.

Intravenous cholecystography is the most diagnostic procedure, if the serum bilirubin values are normal. This was of definite help in roentgenologically dissecting the visualized structures noted in the oral study of Case II. The thirty to forty-five minute interval film demonstrated the usual time of the appearance of the common duct (Fig. 4*A*). Only here, the marked cystic dilatation of the duct was evident with the hepatic ducts mildly dilated. With the continuation of the study the one and two hour interval films revealed that the more lateral and inferior shadow was now filled, (Fig. 4*B*). This is compatible with the gallbladder filling, as we are accustomed to seeing in the routine intravenous cholografin study. The dilated hepatic radicals were more pronounced in the later films with further concentration (Fig. 4*B*). Kanoui[12] has shown by means of intravenous cholangiography an enormous

Fig. 7. Case III. C.E. (*A*) The thirty minute intravenous cholografin study demonstrates a small amount of contrast medium and air in the hepatic ducts and cyst. (Nine years after Roux en Y anastomosis.) (*B*) The two hour intravenous cholecystogram shows further concentration of the contrast medium in the dilated biliary ducts. Note absence of the gallbladder shadow. See text.

cystic dilatation of the common duct; however, his patient was not operated upon and was being treated medically at that time.

In none of our cases was needle aspiration or direct injection of contrast material done preoperatively. Lumpkin and Wilson[16] advocate this method of investigation. They state that gastrointestinal communication, laboratory analysis of the fluid, and exact anatomic relationship of the cyst are obtained. They recommend searching for evidence in an excretory urogram following injection of the opaque medium into the cyst. This would conclusively prove intestinal tract communication of the cyst. Their method is not innocuous and bile peritonitis is a potential hazard.[4,5,29] When complete obstruction or kinking of the common duct occurs at the choledochoduodenal junction, this method is not reliable. If serum bilirubin levels permit, the intravenous cholografin study will probably be superior. We have not had the opportunity of using pneumoperitoneum, but this method is of only questionable value. Pneumoperitoneum with laminagraphic examination may be of assistance, but is not as advantageous as a combination of contrast medium study with laminagraphy.

In the early postoperative period following Roux en Y anastomosis, injection of radiopaque material via a catheter demonstrated that there was delay in emptying of the cyst. The right lateral position produced the greatest degree of evacuation. The standing position showed layering of the opaque medium (Fig. 5). Perhaps these mechanic forces cause intermittent incomplete obstruction and explain the recurrent complaints that these patients experience even though the cyst is decompressed.

Case I had outgrown her anastomosis which necessitated a cholecystojejunostomy. Case III showed obliteration of the earlier choledochoduodenostomy and required a choledochojejunostomy. During the next ten year interval, she had repeated bouts of epigastric distress. Abnormal liver function studies were not demonstrable at any time. This should be contrasted with the early obstruction and liver damage in Case IV. When the cyst causes complete obstruction of the distal end of the common duct due to a valve-like mechanism,[15] kink-

ing, or pressure, one may expect liver damage. However, Case III proves that prolonged symptoms and clinical demonstration of regurgitation do not necessarily mean that there is liver damage (Fig. 7 and Reference 18).

Follow-up study of Case III nine to ten years after Roux en Y anastomosis with intravenous cholografin, demonstrated that the biliary radicals were dilated. Air and contrast material were seen in the cyst, but concentration was never sufficient even when various positions were used (Fig. 7). A similar dilatation of the biliary radicals was seen by Kaplan *et al.*[13] Their four month infant even had the cyst excised completely. Therefore, in the last postoperative period, the intravenous study will demonstrate the dilated biliary radicals and absence of the gallbladder shadow. The gallbladder shadow is probably not seen since the choledochal cyst will prevent concentration when decompressed and the contrast material enters the intestine more readily. The dilated biliary radicals are seen when the cyst is anastomosed or completely removed. This finding has been verified at autopsy by McWhorter.[18] His material showed that even the pancreatic duct may be dilated; nevertheless, the distal end of the common duct and the distal end of the pancreatic duct were normal.

The dilatation of the biliary radicals may be considered a residual or the result of the anastomosis, but seeing its presence prior to surgery and its continuation regardless of the surgical procedure makes one speculate that it may be a reflection of a disturbance at the choledochoduodenal junction. If this is the case, then current primary surgical attack may be too proximal. In a manner similar to megacolon, megaesophagus and megaureter, perhaps we are dealing with a megacholedochus and the primary difficulty is a neuromuscular one. Weber[26] has used the term "autonomic neurodysplasia," to describe the disorder.

From a review of the literature and a study of the present clinical cases (Table 1), one can readily identify a clinical triad of mass, jaundice, and pain, in patients (usually females) with this lesion. Of course, the individual components of the triad vary in severity. A roentgenographic triad may also be established, based on the following three very common and simple findings: (1) soft tissue mass, (2) duodenal impression, and (3) nonvisualized gallbladder. Any two clinical signs in a female patient plus the roentgenographic triad should lead to the correct preoperative diagnosis. Serum bilirubin levels permitting, intravenous cholecystography will confirm the diagnosis. One can expect future case reports to include an increasing number of such demonstrations, and if interpreted properly, a rising increase in the percentage of correct preoperative diagnoses.

SUMMARY

1. The preoperative roentgen features of congenital choledochal cyst are analyzed from plain roentgenographic, oral cholecystographic, barium meal, and intravenous cholografin studies. The usual common findings of this lesion are cited and contrasted with the atypical findings in the literature.

2. An intravenous cholografin demonstration is reported.

3. Criteria are formulated for the diagnosis and a roentgenographic triad is suggested to correlate with the clinical triad.

4. Early and late postoperative roentgenographic studies are evaluated.

5. Intravenous cholografin studies may be of help in understanding the pathogenesis.

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ORABILEX, A NEW ORAL CHOLECYSTOGRAPHIC MEDIUM*

A CLINICAL REPORT ON 112 CASES

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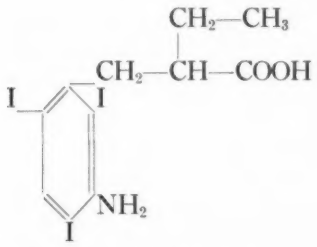
WE HAVE been favorably impressed during a clinical trial with a new cholecystograpic drug, orabilex* and wish to submit a report on its use, based on 112 cases.

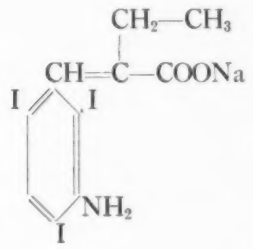
The current favorite oral cholecystographic preparation is telepaque, a triiodo organic compound containing 68 per cent iodine. Its chemical formula is 3(3 amino-2:4:6:-triiodophenyl) 2-ethyl propionic acid:



A multiplicity of publications attest to the superiority of telepaque over the formerly widely-used media.[1–6,8,10] With telepaque, the gallbladder shadows are denser, the side reactions fewer, visualization failures less common, and duct opacification after a fatty stimulation occurs not infrequently.

The less desirable features of telepaque are the side reactions, particularly diarrhea, and the virtual constant presence of discrete bowel opacities. These may prove troublesome technically, when located near or superimposed upon the gallbladder shadow. Telepaque is generally administered in 3 gm. dosage (6 tablets of 0.5 gm. each) although heavy patients usually require a larger dose for satisfactory visualization.

Orabilex is the sodium salt of a triiodo organic compound containing 57 per cent iodine. Chemically, it is 3(3 amino butyryl 2:4:6 triiodophenyl) 2-ethyl acrylic sodium.



The remarkable feature of this compound is the low number of side reactions after oral administration of 6 gm. This dose was given routinely to all adult patients, regardless of weight. Six tablets of 1 gm. each were employed. Since this is twice the dose of telepaque, it was not entirely surprising to find very dense gallbladder shadows, even in patients over 200 pounds in weight. Nevertheless, this 6 gm. dose of orabilex was tolerated with minimal discomfort, contrasted with the 12–40 per cent incidence of diarrhea after 3 gm. of telepaque (Table 1A).[1,6,10]

Our clinical material consisted of 112 patients, in 82 of whom gallbladder studies were requested because of suspected biliary tract disease. The sex, age and weight distributions are shown in Table II, and can be considered an average cross section of the individuals seeking diagnosis for various gastrointestinal complaints.

In addition to the low number of side reactions, a low incidence of confusing bowel opacities was noted. Although opacities are found in virtually every patient after telepaque, in our series only 18.7 per cent of the

* Orabilex supplied by E. Fougera & Co., Hicksville, New York.

* From the Department of Radiology, Kensington Hospital, Philadelphia, Pennsylvania.

TABLE I

Opaque Medium	Telepaque (3 gm.)			Orabilex (6 gm.)	
Authors No. of Cases	Whitehouse and Martin[10] 500 cases	Dunne *et al.*[1] 116 cases	Morgan and Stewart[6] 100 cases	Authors' Series 112 cases	Pichard[7] 20 cases
A. Side Effects	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
None	62.5	79.6	45.5	87.5	95.0
Nausea	5.8	8.6	11.0	8.0	0.0
Vomiting	0.5	0.0	0.0	1.8	0.0
Diarrhea	25.3	12.0	40.0	1.8	5.0
Dysuria	13.7	0.8	—	0.0	0.0
Others	2.8	—	—	5.4	0.0
B. Gallbladder Density			Renck[8] 65 cases		
Excellent	59.6	40.0	↑ 74.0 ↓	70.5 (calculi 6.3)	→ 95.0 →
Good	23.4	43.0		16.1 (calculi 6.3)	
Fair	↑ 7.6 ↓	9.6	11.0	3.6 (calculi 1.8)	—
Poor		2.8	8.0	5.4 (calculi 5.4)	—
None	9.4	4.4	7.0	4.5 (calculi 0.9)	5.0
C. Duct Visualization after Stimulation					
Excellent—Good	↑ occasional ↓ case ↓	—	25.0	40.0	↑ 50.0 ↓
Faint—Poor		—	14.0	25.0	
None	↑	—	—	25.0	—
D. Bowel Opacities	—In almost every case— ↓			18.7 minimal opacities	5.0

patients showed any areas of increased density in the bowel contents after orabilex. Moreover, these were not discrete densities, but rather diffuse faint opacifications of bowel contents, entirely unconfusing in the gallbladder evaluation.

DENSITY OF GALLBLADDER SHADOW

The radiopacity of the gallbladder shadows, although not measured photometrically, was greater on the average than in a corresponding number of telepaque studies. The grading of densities is shown in Table

1B, including comparison with reported telepaque series.

In 79 patients (70.5 per cent) including 7 with calculi, a high density of the gallbladder was demonstrated, greater than usually seen after telepaque. In 18 patients (16.1 per cent) a good opacification was obtained, equivalent to the usual telepaque density. In only 2 patients without calculi (1.8 per cent) was opacification merely fair, and faint or poor visualization was seen in no patients without calculi. We were particularly gratified at the excellent opacification in patients over 200 pounds. There were 8 such individuals, the heaviest being 260 pounds.

There were 5 patients with nonvisualized gallbladders. In 1, a large opaque calculus was noted. Two of the other 4 patients had liver disease and some degree of jaundice. The remaining 2 had nonfilled gallbladders even after intravenous cholecystographies and cholangiographies with cholografin; surgery disclosed calculi in both blocking the cystic duct.

This orabilex series suggests definite superiority in density and number of gallbladder visualizations.

Table IIIB. reveals data in a study on 10 patients who had both telepaque and orabilex studies, with a two month period intervening between studies. In every patient, gallbladder opacification was more dense with orabilex, and in patient 8, a calculus was diagnosed by orabilex though not apparent in the faint shadow of the telepaque examination.

DUCT OPACIFICATION

Opacification of the ducts (cystic, hepatic and common), was observed in a high percentage of patients during orabilex studies (Table 1C). In only 25 per cent of the patients receiving a fatty meal was duct opacification absent. Visualization of some degree was noted in 65 per cent of all cases, a good to excellent density in 40 per cent, and a fair to faint opacification in 25 per cent.

In our series of 10 patients who had both studies (Table IIIC), 6 showed duct opacification after orabilex but not after telepaque. The reverse situation was not observed in any patient. Further interesting facets of the duct opacification will be taken up in the discussion.

Table II

Sex Distribution	Per Cent
Male—49	43.75
Female—63	56.25
Age Distribution	**Per Cent**
Under 20— 2	1.8
20–29— 8	7.1
30–39—25	22.3
40–49—25	22.3
50–59—18	16.1
60–69—26	23.2
70–79— 5	4.5
80–+— 3	2.7
Weight Distribution	**Per Cent**
Under 100 lb.— 1	0.9
100–119— 8	7.1
120–139—20	17.9
140–159—37	33.0
160–179—28	25.0
180–199—10	8.9
Over 200— 8	7.1
Total Patients 112	

BOWEL OPACIFICATION

Telepaque reports (Table 1D) indicate that a varying degree of discrete opacification in the bowel is an almost constant finding after telepaque. Although usually not confusing, these discrete densities occasionally are difficult to separate from the gallbladder shadow, making the study inconclusive. This has occurred not infrequently in our own experience.

After orabilex, in only 18.7 per cent of the patients were colonic opacities apparent. In almost all of these, the opacification was not discrete, but rather a diffuse density of colonic contents in one segment of the colon, not interfering with clear gallbladder delineation and practically never producing discrete shadows which could be mistaken

TABLE III

COMPARISON OF TELEPAQUE WITH ORABILEX IN SAME INDIVIDUALS

Patient		A. Side Effects		B. Gallbladder Density		C. Common Duct Density		D. Bowel Opacities	
No.	Weight (lb.)	Telepaque	Orabilex	Telepaque	Orabilex	Telepaque	Orabilex	Telepaque	Orabilex
1	132	o	o	++++	+++++	o	o	+	± diffuse
2	175	o	o	++	++++	o	++	+	± diffuse
3	148	o	o	++	++++	o	+	++++	o
4	232	o	o	++	++++	o	++	++	o
5	211	o	o	++++	+++++	o	o	++	± diffuse
6	168	o	o	+++	++++	o	+	+++	++ diffuse
7	142	o	o	+++	+++++	±?	±?	++++	+ diffuse
8	155	o	o	+	++++	o	+	+	o
9	142	diarrhea	o	+++	++++	o	+	+++	o
10	138	diarrhea	o	+++	++++	o	o	++++	± diffuse

for opaque calculi. Our comparative study (Table IIID) indicates minimal to extensive bowel opacities in every patient after telepaque. After orabilex, no opacities were seen in 4 patients, slight diffuse increase in bowel segments was noted in 4 others, and in only 2 were the bowel opacities approaching the densities and degree seen after telepaque.

TOLERANCE, TOXICITY, AND SIDE EFFECTS

Although 6 one gram tablets were uniformly given to every patient, a low incidence of toxicity or side effects was observed. The comparative side effects from telepaque and orabilex are shown in Table IA. It will be noted that 87.5 per cent of all the patients had no subjective or objective effect from the orabilex, as contrasted with literature reports on telepaque, which range from 45–79 per cent. Our questioning of orabilex cases was detailed and thorough, and many questionable side effects are included as reactions, although initially the patient indicated no obvious effect. This was particularly true about mild abdominal pain. Thus, of the 7 patients (5.4 per cent) with abdominal pain or cramps after orabilex, 5 had been having frequent abdominal pain or cramps as their clinical complaint, and could not be sure whether the orabilex was responsible for this symptom. Also 5 of 9 patients with mild nausea admitted that this was a clinical complaint which led to the gallbladder study. If these patients were excluded from the positive side effect series, the statistical incidence of side effects would be less than 5 per cent. Actually, only 1 patient developed truly annoying nausea and vomiting, shortly after taking the orabilex tablets. This was a severe neurotic, with similar incidents previously after other medication and drugs. Diarrhea, vomiting and dysuria were virtually nonexistent.

Our comparative study of Table IIIA shows diarrhea in 2 patients after telepaque but no side effects after orabilex.

DISCUSSION

In studies carried out in the laboratories of André Guerbet and Company, in Paris, orabilex was found to be of low toxicity. Acute intravenous injections into mice revealed a LD_{50} of 570 mg./kg. and intravenous administration of 200 mg./kg. evoked no observable discomfort or reaction in rabbits. By oral administration, this same dose was completely nontoxic to cats.

Studies carried out in this country* disclosed a LD_{50} of 2,200 mg./kg. by oral administration in one dose in rats. No visual toxic effects were observed on surviving animals. With dogs, daily oral doses up to 1,500 mg./kg. were given for a two week period without apparent effect. Liver and kidney studies were normal. All the animals were sacrificed and no significant gross or histologic alteration was uncovered in any organ.

This low degree of animal toxicity appears to be carried over to humans, as far as our clinical trial could go. Patient discomfort after 6 gm. of orabilex was completely absent in 87.5 per cent of the 112 patients. In only 4 patients could the mild nausea be attributed to the orabilex. Likewise, the presence of mild cramps (without diarrhea) could be attributed to the drug in only 2 patients. The other 5 could not distinguish these mild cramps from their clinical complaints. In the 10 patients receiving first telepaque and later (after two months) orabilex, the nontoxicity of orabilex was confirmed. Diarrhea was noted in only 2 of the entire series of 112 patients. In 1 it was a prior complaint. No dysuria was encountered. With all factors considered, side reactions could be regarded as insignificant.

A consistently high degree of density was encountered, even in patients of unusual girth and weight (Table III B). This density definitely increased diagnostic accuracy. We encountered a number of such instances. One patient showed a gallbladder of fair density after telepaque, but on one roentgenogram there was a suspicious small translucency. A repeat examination with orabilex produced a very much denser shadow, and the defects of 2 small papillomata were clearly demonstrated. Surgery corroborated the orabilex findings. Another patient had nonopaque stones clearly demonstrated after orabilex which were not apparent after telepaque. In one quite ill patient a telepaque study showed no contrast medium in the biliary tract. A repeat orabilex examination disclosed a huge gallbladder with stones and a long, greatly dilated common duct. Surgery corroborated common duct obstruction, fortunately due to calculi and not to tumor as we had suspected.

This latter case also illustrates the satisfying biliary duct visualization we encountered. In addition to the high percentage of duct opacification after fatty meal (Table IC), in two patients with nonvisualized gallbladders the common duct was opacified. In one, an opaque calculus was seen, but in the other the duct visualization indicated gallbladder disease with cystic duct blockage rather than possible liver dysfunction. The more frequent biliary duct visualization after orabilex is borne out in our comparative studies on 10 patients (Table IIIC); the ducts were clearly delineated in 6, questionably in 1 patient.

The low incidence of bowel shadows after orabilex is readily seen in Table ID. In Table IIID the difference in intestinal opacities after telepaque and orabilex in the same individuals is indicated. Not only is the incidence low after orabilex, but bowel densities, when observed, are primarily diffuse opacifications, and not the discrete small densities which could be mistaken for calculi, or partially mask the gallbladder shadow, at times. The fact that orabilex is water soluble (a sodium salt) and eliminated mainly through the kidneys probably explains its spareness in the bowel and the diffuse colonic staining when present.

Studies for pseudo-albuminuria, which occurs after administration of other gallbladder media, have not yet been carried

* Leberco Laboratories, Roselle Park, New Jersey.

out with orabilex. The chemical structure and high degree of elimination through the kidney favor the probability that pseudoalbuminuria will also occur after orabilex. We expect to study this phase later.

Our evaluation of orabilex is substantiated by the pilot series carried out by Pichard[7] on 20 patients (Table 1). He obtained highly satisfactory visualization in 19; duct opacification was noted in 10 patients. A mild diarrhea was observed in 1 patient; this individual also had a slight degree of opaque intestinal residue. No other side reactions were found.

SUMMARY AND CONCLUSIONS

1. A new oral gallbladder medium, orabilex, clinically tried on 112 patients, impressed us as having definite advantages.

2. Orabilex, containing 57 per cent iodine, was administered in 6 gm. doses routinely to all adult patients, regardless of weight.

3. The low incidence of side reactions with this dose indicates its nonirritative features on the gastrointestinal tract.

4. Gallbladder opacification was usually dense and there were few cases of nonvisualization. In a number of cases which previously had been studied with telepaque, the orabilex studies proved more diagnostic.

5. Satisfactory duct opacification after fatty stimulation occurred in a high percentage of cases. In some instances, duct visualization was obtained in the presence of a nonvisualized gallbladder.

6. A low incidence of bowel opacities was noted. When the medium entered the bowel, it diffusely stained its contents, but did not generally give rise to scattered small opacities.

7. In 10 individuals receiving both telepaque and, later, orabilex the latter appeared superior.

8. It is hoped that other investigators will further evaluate orabilex, confirming our favorable impressions.

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ADDENDUM

Since submitting this report, another 150 patients have received orabilex, with substantially the same favorable findings as reported above. Over 100 of these received a smaller dose (6 capsules of $\frac{3}{4}$ grain each), with no significant alteration of the above findings.

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VOL. 80, NO. 6

DIAGNOSIS OF TUMORS OF THE PANCREAS WITH THE AID OF PNEUMORETROPERITONEAL PANCREATOGRAPHY AND SPLENOPORTOGRAPHY*

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THE diagnosis of pancreatic abnormalities by conventional roentgenologic techniques is difficult. The pitfalls of underdiagnosis and the temptations to overdiagnosis are well known to every roentgenologist. A great increase in interest in our difficulties and responsibilities in the diagnosis of pancreatic lesions is evidenced by the almost exponential rise in the number of publications on this subject in the past few years.

CONVENTIONAL TECHNIQUES

Several roentgenologic methods may be used in the investigation of the pancreas. Because of the usual symptomatology in these patients, the most commonly employed is gastroduodenal examination with barium sulfate suspension. The retrospective studies which have been reported are concerned with the findings of this type of examination.[1,2,7,8] Unfortunately, localization of masses by such methods depends upon the types of extrinsic deformity of the gastrointestinal tract produced and, as is well known, the accuracy of the technique is of a low order of magnitude. Figure 1, *A* and *B* demonstrates the appearance of extrinsic deformities in 2 patients, one (Fig. 1*A*) with a large hepatoma, the other (Fig. 1*B*) with a pancreatic tumor. Roentgenologic differentiation was not possible. As has been frequently pointed out, widening of the duodenal loop may be present, as in the case of Figure 2, in carcinoma of the pancreas; it is also generally accepted that this finding is difficult to evaluate in an individual case and may

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Renografin Oral and Duografin used in these studies were supplied by The Squibb Institute for Medical Research.

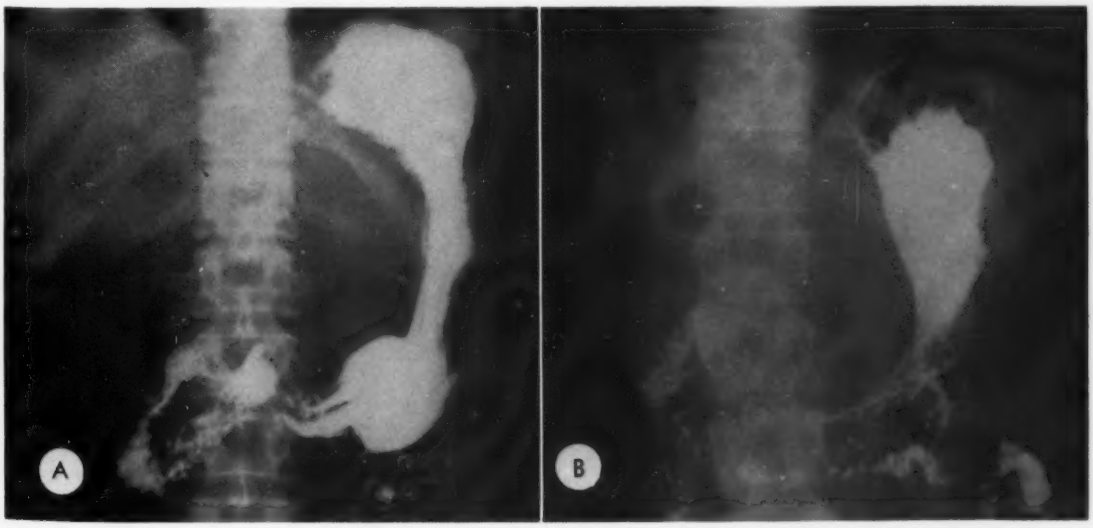

FIG. 1. (*A*) (U-289485) Hepatoma displacing the stomach. (*B*) (U-54853) Carcinoma of the pancreas displacing the stomach.

Fig. 2. (U-162091) Large pancreatic neoplasm with widening of the duodenal loop.

Fig. 3. (U-662298) Invasion of the second portion of the duodenum by carcinoma of the pancreas. This was called normal by the fluoroscopist.

be present even in the absence of any abnormality.

However, despite the difficulties involved, the diagnosis of carcinoma of the pancreas will be made or rendered probable in approximately 25 per cent of cases by gastroduodenal examination. Retrospective examination of roentgenograms will demonstrate suggestive changes in the stomach and duodenum in 50 per cent of cases of pancreatic neoplasm.[7] Thus, more meticulous examination, particularly of the second portion of the duodenum, and attention to the possibility of diagnosis will be effective in increasing diagnostic accuracy.

Small areas of invasion (Fig. 3), particularly of the second portion of the duodenum, are among the findings most commonly overlooked. Small lesions will as frequently produce roentgen findings as large ones, since the abnormalities are usually due to invasion of the wall of the duodenum (Fig. 4) and not to increase in tumor size. While the "reverse 3 sign" or epsilon (ϵ) sign (Fig. 5*C*) is probably always indicative of abnormality, it is not completely diagnostic of pancreatic neoplasm alone since it may also result from cholangitis or pancreatitis.[5,13] The impression produced in the duodenal bulb because of a dilated common duct associated with

Fig. 4. (U-633643) Pancreatic adenocarcinoma invading the second and third portions of the duodenum. Note the dilatation of the duodenum proximal to the area of invasion.

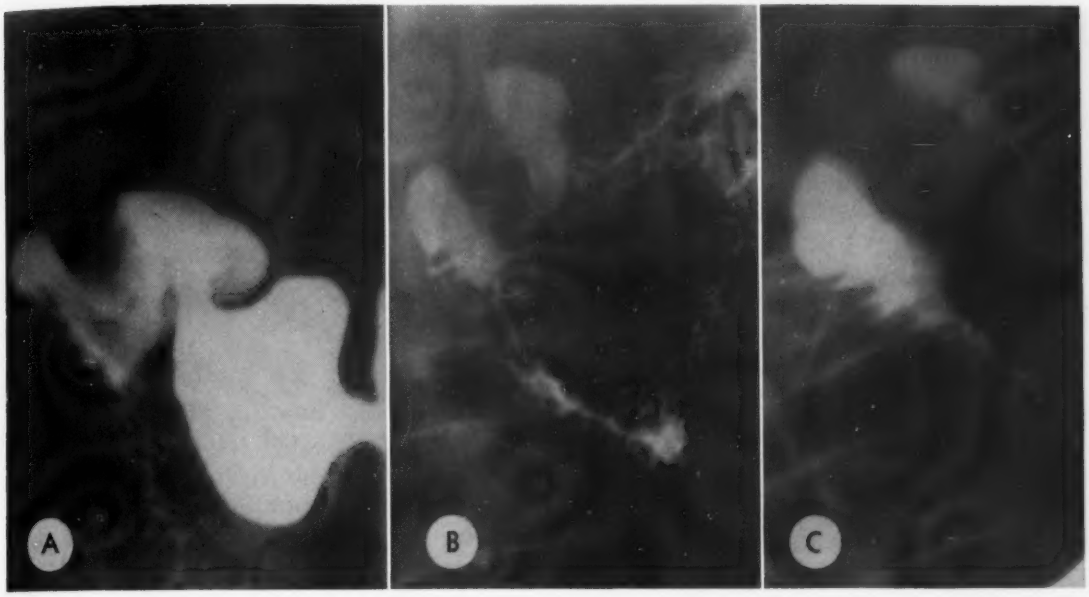

Fig. 5. (U-433098) (*A*) Male, aged sixty-seven, with carcinoma of the head of the pancreas; characteristic deformity of the duodenal bulb. (*B*) Impression on the bulb caused by greatly distended common duct. (*C*) Epsilon sign in second portion of the duodenum.

mucosal abnormalities in the second portion of the duodenum (Fig. 5, *A* and *B*) is a valuable and relatively reliable sign when present, but is unfortunately not common.

As in many situations in roentgenologic diagnosis, the presence of several ancillary findings leads more certainly to accurate diagnosis. Meticulous and exhaustive examination of each case suspected of having a pancreatic neoplasm is the only means at present of increasing our diagnostic accuracy. In other tumors increase in diagnostic ability has resulted in improvement in therapeutic techniques; it is to be hoped that such may be the case in this lesion which has such a poor prognosis presently.

It is for this reason—*i.e.*, to more meticulously investigate each case in order to accumulate reinforcing evidence—that newer additional techniques, such as operative pancreatography,[3] pancreatic angiography,[14] pneumoretroperitoneal pancreatography and splenoportography have been advocated in the investigation of patients suspected of harboring pancreatic neoplasm. We have evaluated pneumoretroperitoneal pancreatography and splenoportography in a small series of 25 cases and wish to present here the results correlated with gastroduodenal examinations, duodenal exfoliative cytology, and surgical or autopsy findings.

PNEUMORETROPERITONEAL PANCREATOGRAPHY

By opacifying the stomach and duodenum with orally administered organic iodine compounds (renografin oral), the biliary and urinary tracts with intravenously administered medium (duografin, a combination of cholegrafin and renografin) and by injecting retroperitoneally carbon dioxide by the presacral route, it is possible to outline the pancreas, to determine its position and size, and to detect lesions producing an increase in size of this organ. The technique of presacral pneumoretroperitoneum has been described elsewhere[9] and will not be detailed here. Carbon dioxide is used instead of air in order to increase the safety of this procedure by the prevention of embolism.[12] The only disadvantage of this gas is that its rapid absorption requires that roentgenographic procedures ensue with alacrity after its in-

FIG. 6. (U-669814) Male, aged seventy-four. Oral renografin in the stomach; duografin intravenously with visualization of kidneys and gallbladder; 1,000 cc. of carbon dioxide retroperitoneally.

jection. For the special purpose of pneumoretroperitoneal pancreatography, the injection is made preferably with the patient in the knee-chest position. Some of these patients because of pain or debility are unable to assume this position and the examination is then done with the patient lying on his right side so that the gas fills the left retroperitoneum. The oral organic iodine compound is used instead of barium for two reasons: first, only 30 cc. is required to completely outline the stomach and duodenum, avoiding the possibility of obscuring retroperitoneal details with a larger quantity of opaque material; and secondly, it has been observed in using these compounds for gastroduodenal fluoroscopy that there is routine rapid flow of the material into the duodenum through the pylorus without the delay occasionally seen with barium suspensions.

The technique of pneumoretroperitoneal pancreatography used in this series is as follows: the intravenous material is administered first so that time is allowed for the biliary and renal systems to visualize; the presacral pneumoretroperitoneum is

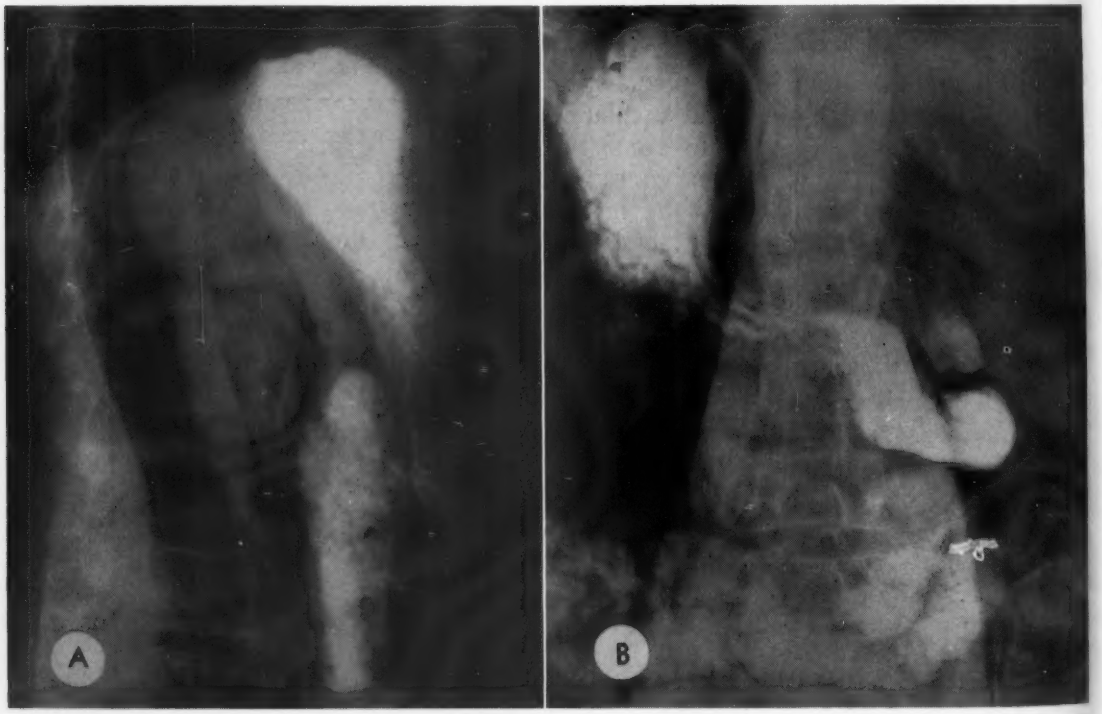

FIG. 7. (U-666236) (*A* and *B*) Normal pancreas demonstrated on the lateral roentgenogram. Oral renografin and intravenous duografin used. Radiolucent gallstone is visualized in the gallbladder. Patient had positive duodenal cytology. Operative proof of normality.

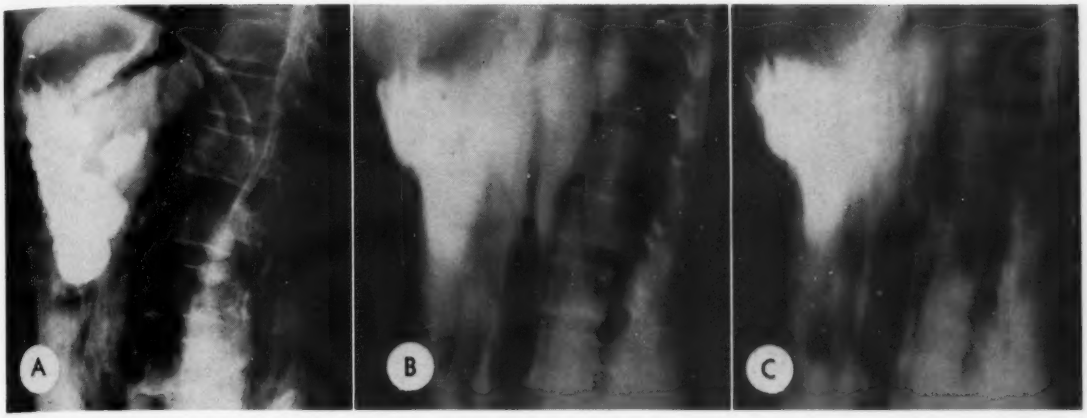

Fig. 8. (U-564578) Female, aged fifty-three, had suspected pancreatic abnormality. (*A*) Lateral abdominal roentgenogram made after the retroperitoneal injection of 1,000 cc. of carbon dioxide did not adequately delineate the pancreas. (*B* and *C*) Laminagrams made at various levels demonstrate the normal size of the pancreas. Exploratory operation revealed a normal pancreas.

then accomplished; and finally, just before roentgenographic examination begins, the patient ingests the oral iodine compound. Figure 6 is a prone abdominal roentgenogram made following these procedures. The gallbladder is filled with opaque material; the kidneys are outlined by carbon dioxide and their collecting systems contain opaque material. The adequate outlining of the stomach with only 30 cc. of organic iodine compound is demonstrated. The outline of the pancreas is difficult or impossible to appreciate on prone roentgenograms.

Figure 7, *A* and *B* are prone and lateral roentgenograms in a case in which duodenal exfoliative cytology was reported as showing malignant cells. No abnormality had been demonstrated by gastroduodenal examination. The patient had silent jaundice. Pneumoretroperitoneal pancreatography was interpreted as showing no mass in the region of the pancreas; a radiolucent gallstone was noted. Surgery demonstrated a stone in the common duct but no evidence of neoplasm of the pancreas or biliary system. This case is one of the two false

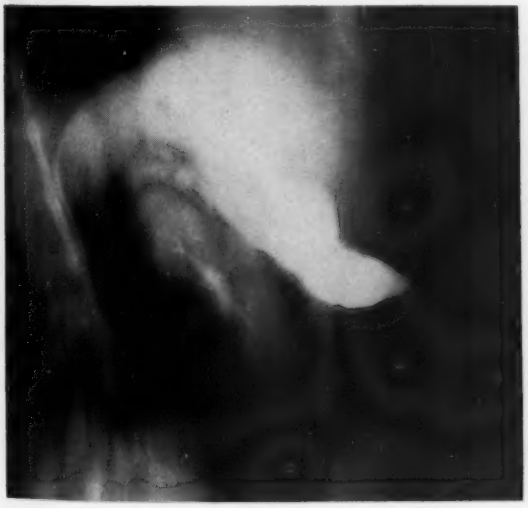

Fig. 9. (U-654627) Normal lateral laminagram with good visualization of left kidney, adrenal and tail of pancreas.

Fig. 10. (U-662298) Pneumoretroperitoneal pancreatogram demonstrates a large mass in the head of the pancreas in a fifty-one year old male.

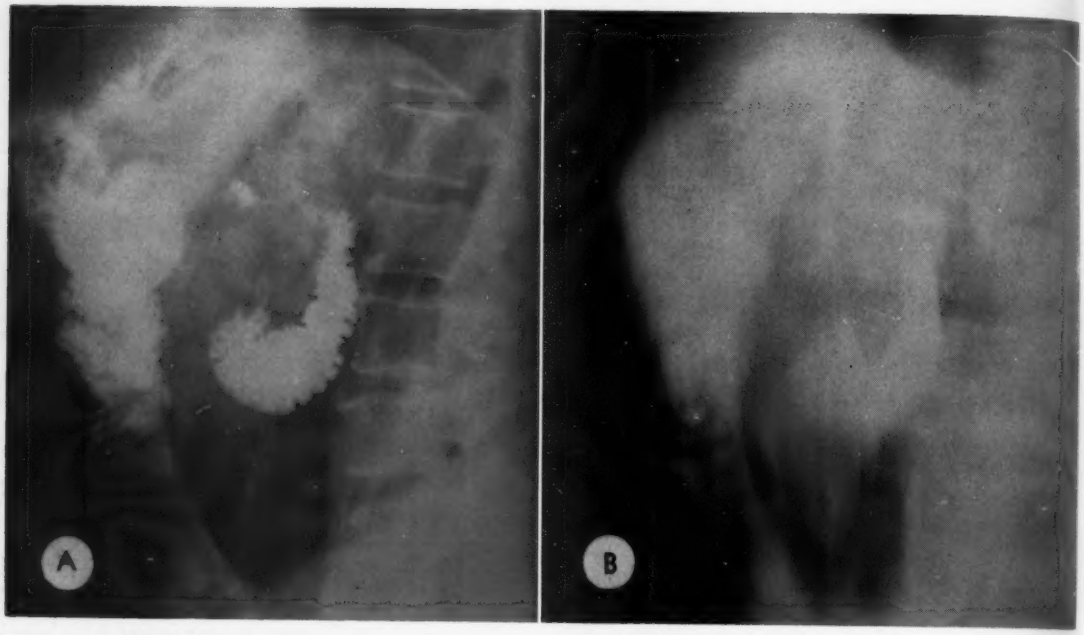

FIG. 11. (U-658262) (*A*) Lateral pneumoretroperitoneal pancreatogram of a male of sixty-two years, demonstrating a large mass in the pancreas. (*B*) Laminagram demonstrates the position of this mass in the body of the pancreas.

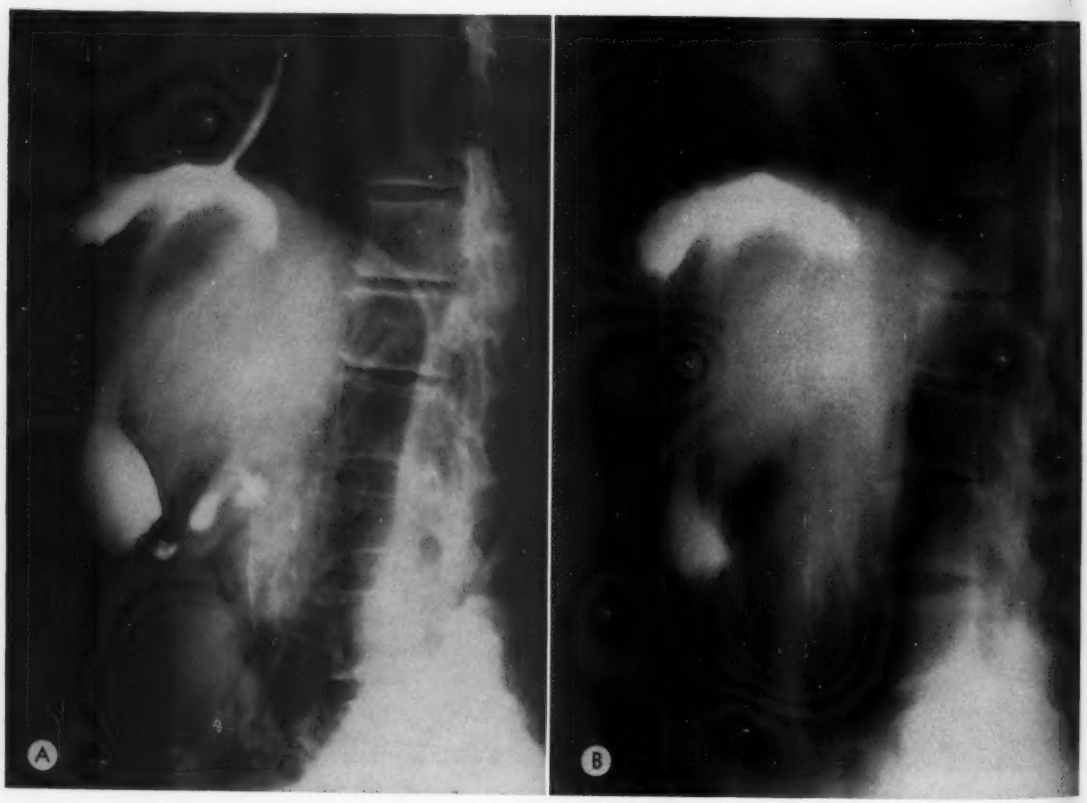

FIG. 12. (U-682990) Mass in body and tail of pancreas deforming the posterior wall of the stomach. Pneumoretroperitoneal pancreatogram. (*A*) Lateral view. (*B*) Lateral laminagram.

positive duodenal cytologic examinations in our series. Duodenal cytology correlated with chemical analysis of pancreatic secretions is done in our institution by Dr. Howard Raskin and is, in his hands, a reliable procedure. This procedure has been performed in 300 cases. Of 35 cases of pancreatic neoplasm, cytology was positive in 21. Analysis of secretions indicated abnormality in an additional 10 cases.[10] The 4 "false negative" and the 2 "false positive" examinations mentioned before again emphasize the necessity of obtaining and evaluating all sources of evidence in the individual case.

Laminagraphy is an integral part of pneumoretroperitoneal pancreatography (Fig. 8, *A*, *B* and *C*). Figure 9 is a section well to the left of mid-line cutting through the collecting system of the left kidney, the left adrenal and the body and tail of the pancreas, which in this case was normal. Laminagraphy thus facilitates localization of lesions and diagnosis of neoplasms of the body and tail of the pancreas which tend to be clinically more obscure.

Figure 10 represents the pneumoretroperitoneal demonstration of a large mass in the head of the pancreas in a patient with jaundice, an invasive lesion of the second portion of the duodenum, positive duodenal cytology, and vascular occlusion shown by splenoportography. The roentgen findings were confirmed at surgery.

Figure 11, *A* and *B* demonstrates a mass in the body of the pancreas. Laminagraphic section just to the left of the mid-line brings the mass into the plane of minimum unsharpness. Figure 12, *A* and *B* demonstrates a mass in the body and tail of the pancreas by the same technique.

The use of the various opaque compounds to outline the stomach and duodenum, the kidneys and the biliary system is the major point of differentiation of our currently used technique from those described by von Moos,[15] and Sansone *et al.*[11] These authors utilized pneumoretroperitoneal air contrast and air contrast of the stomach in investigation of lesions of

Fig. 13. (U-678675) Mass in the uncinate process of the head of the pancreas displacing the lower end of the common duct.

the pancreas. Figures 13 and 14, *A* and *B* demonstrate the utility of the addition of the contrast media. In Figure 13 a large mass in the uncinate process of the head of the pancreas is seen; the adequate visualization and slight posterior displacement of the common duct accurately localize the lesion. Figure 14, *A* and *B* demonstrates the displacement of the right ureter by a large lesion in the head of the pancreas; the ureter is displaced laterally and posteriorly by this invasive neoplasm.

If pneumoretroperitoneal pancreatography has a place in the diagnosis of neoplasm, that place is earlier in the course of disease than in the case demonstrated in Figure 15. Examination in this case was, of course, unnecessary for diagnosis; clinically there was no doubt; the patient's condition was obviously terminal. Pneumoretroperitoneal pancreatography demonstrated a huge pancreatic mass markedly deforming the gastrointestinal tract. The carbon dioxide was, rather unusually, all anterior to the mass. At autopsy three days later a widely metastatic pancreatic carcinoma

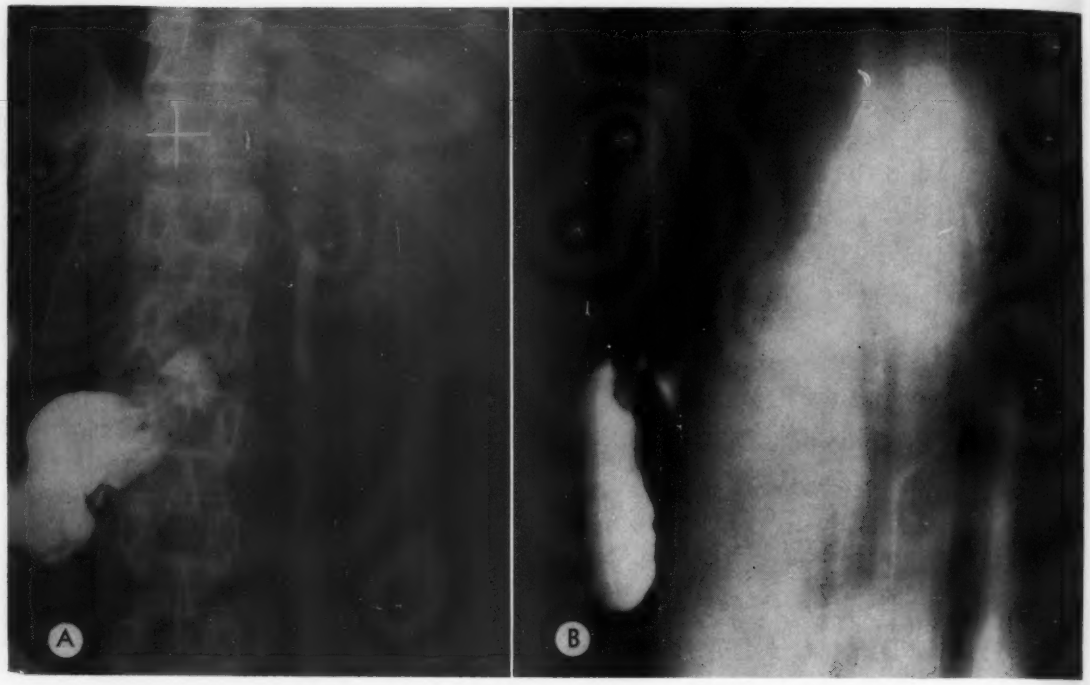

Fig. 14. (U-684677) (*A* and *B*) Large pancreatic mass in the head of the pancreas displacing the right ureter.

was found. All of the retroperitoneal structures were involved in a solid invasive mass which had precluded their being outlined by retroperitoneal gas injection.

SPLENOPORTOGRAPHY

Percutaneous splenoportography[4] is a technically simple, reasonably safe procedure which provides very important information concerning the veins of the upper abdomen. While it is true that portal hypertension constitutes the primary in-

Fig. 15. (U-539715) Huge pancreatic tumor demonstrated by anterior displacement of the stomach three days before patient expired.

Fig. 16. (U-663992) Normal splenoportogram in a sixty-seven year old male with a small carcinoma of the pancreas. Successful Whipple operation. Patient died of generalized metastases four months later.

dication for this procedure, it can also be used with advantage in the investigation of patients with pancreatic neoplasm. Splenoportal obstruction can be accurately diagnosed and localized preoperatively. Involvement of the retroperitoneal veins suggests such extensive invasiveness that only palliative surgical procedures are indicated. Lack of such involvement should encourage the surgeon to more radical attack.

Figure 16 is a normal splenoportogram in a patient with a small carcinoma of the head of the pancreas. As predicted by this examination, a pancreaticoduodenectomy was technically simple, and there was no retroperitoneal invasion by this neoplasm.

In the case illustrated in Figure 17, however, occlusion of the splenic vein had been produced by carcinoma of the head of the pancreas and, moreover, retroperitoneal invasion had resulted in partial occlusion of the inferior vena cava so that visualization of the vertebral-azygos system was ob-

Fig. 17. (U-662298) Male, aged fifty-one, with occlusion of the splenic vein by carcinoma of the head of the pancreas.

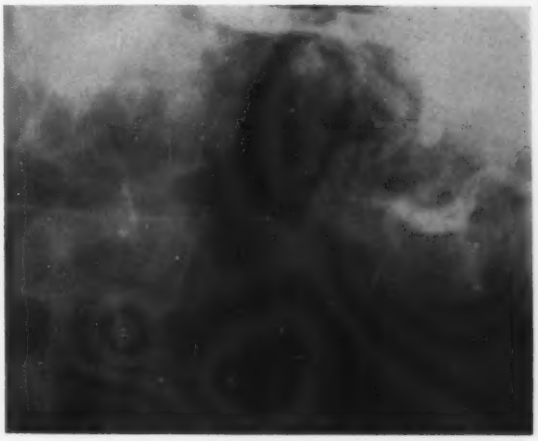

Fig. 18. (U-658262) Splenoportogram demonstrates complete occlusion of the splenic vein due to neoplastic involvement. The tumor mass causes elevation, compression and occlusion of the splenic vein in the region of the tail of the pancreas. Collateral circulation is through the vasa brevia.

tained. This patient was treated by cholecystogastrostomy and by interstitial radiation therapy, utilizing I^{131} introduced into polyethylene tubing sewn through the pancreas at this operation.[6] Because of the splenoportographic findings, no attempt at radical surgery was made.

In another case, which had been diagnosed as carcinoma of the body and tail of the pancreas by cytology and by pneumoretroperitoneal pancreatography, splenoportography (Fig. 18) demonstrated completed occlusion of the splenic veins due to neoplastic involvement. The tumor mass caused an elevation of the splenic vein with compression just proximal to the area of complete occlusion. Collateral circulation was through the vasa brevia. Definitive surgery was not feasible.

Figures 19 and 20 demonstrate lesser but still significant degrees of vascular involvement. In both of these cases the pancreatic mass had caused compression of the splenic and portal veins at their junction with the superior mesenteric vein. Definitive surgery was not feasible in either case.

DISCUSSION

Twenty-five patients have been examined by means of pneumoretroperitoneal pan-

FIG. 19. (U-678675) Compression of the splenic vein from carcinoma of the uncinate process of the head of the pancreas. Gallbladder is outlined by residual opaque material from previous pneumoretroperitoneal pancreatography.

FIG. 20. (U-682990) Compression without occlusion of the splenoportal circulation by carcinoma of the pancreas.

creatography. A pancreatic mass has been demonstrated in 17 cases by this technique; all of these cases have been confirmed by surgery or autopsy. Duodenal cytology and pancreatic secretion studies were positive in all except one of these cases. Gastroduodenal examination revealed abnormalities in the second portion of the duodenum in all 17 cases. The pancreas was thought to be normal in 8 cases. One of these, with positive duodenal cytology, was found at surgery to have a small ampullary lesion without significant increase in size of the head of the pancreas.

Splenoportography was done in 7 of the 17 cases with demonstrated pancreatic enlargement. In all but one case involvement of the vessels was demonstrated; in that one case, radical pancreaticoduodenectomy was technically simple.

SUMMARY AND CONCLUSIONS

Pneumoretroperitoneal pancreatography, utilizing contrast media to outline the stomach and duodenum, the biliary system and the urinary tract, is a useful method in the meticulous investigation of patients suspected of having pancreatic neoplasm.

Splenoportography done preoperatively in patients with pancreatic masses may be of help in planning for or excluding the possibility of definitive radical surgery.

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THE PRACTICAL VALUE OF THE INTERNAL CEREBRAL VEIN IN THE ANTERO-POSTERIOR PHLEBOGRAM*

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OUR experience with phlebograms in more than 1,000 carotid angiographies employing the Chamberlain biplane stereoscopic device[1,2,3] has indicated that the most valuable finding is the demonstration of lateral displacement of the internal cerebral vein. Each internal cerebral vein runs in the roof of the third ventricle 1 mm. lateral to the midline. In the anteroposterior projection, the opacified vein, lying in the axis of the roentgen-ray beam, is seen as a dense round spot which for practical purposes is a midline vascular landmark.

Only very rarely does the lateral phlebogram in itself provide evidence leading to the diagnosis of an expanding intracranial lesion. Commonly there may be marked lateral shifting of the internal cerebral vein in the anteroposterior projection with a normal pattern of the deep cerebral veins in the simultaneously exposed lateral projection.

The internal cerebral vein lies well below the edge of the falx cerebri and anterior to the tentorium cerebelli (Fig. 1). In this position, it is much more vulnerable to lateral displacement than the pineal gland, which is somewhat protected by these fixed structures. When visualized, it provides more critical evidence of lateral displacement of midline structures than the traditional pineal gland, which is not always calcified sufficiently for visualization.

Stereoscopy is valuable in demonstrating minimal derangement of this vein permit-

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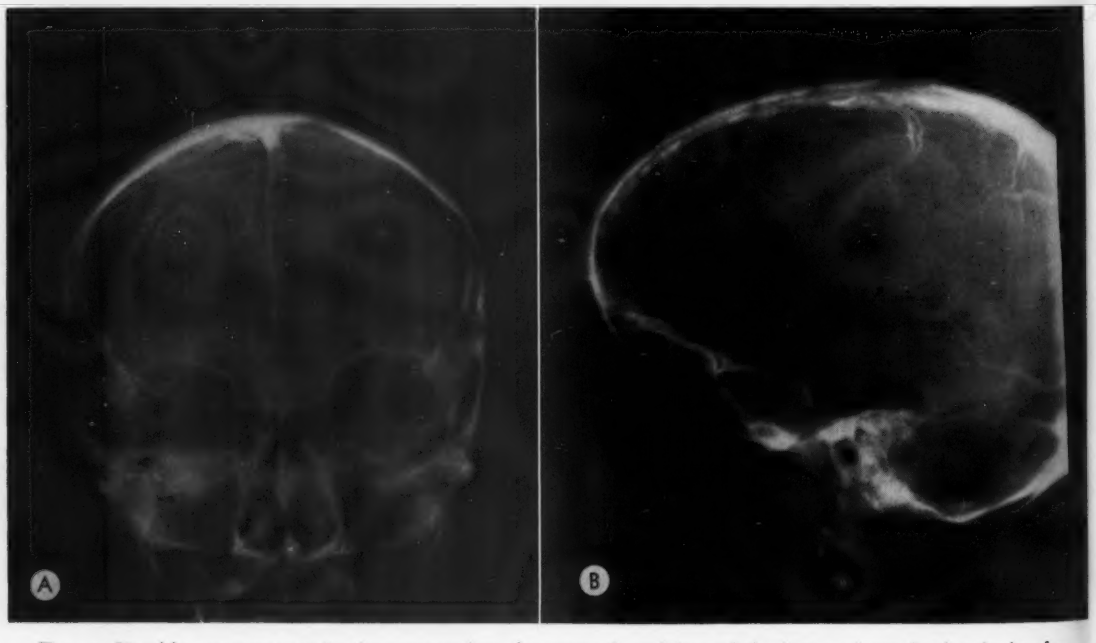

FIG. 1. Double contrast study demonstrating the normal position of the internal cerebral vein in the anteroposterior (*A*) and lateral projections (*B*).

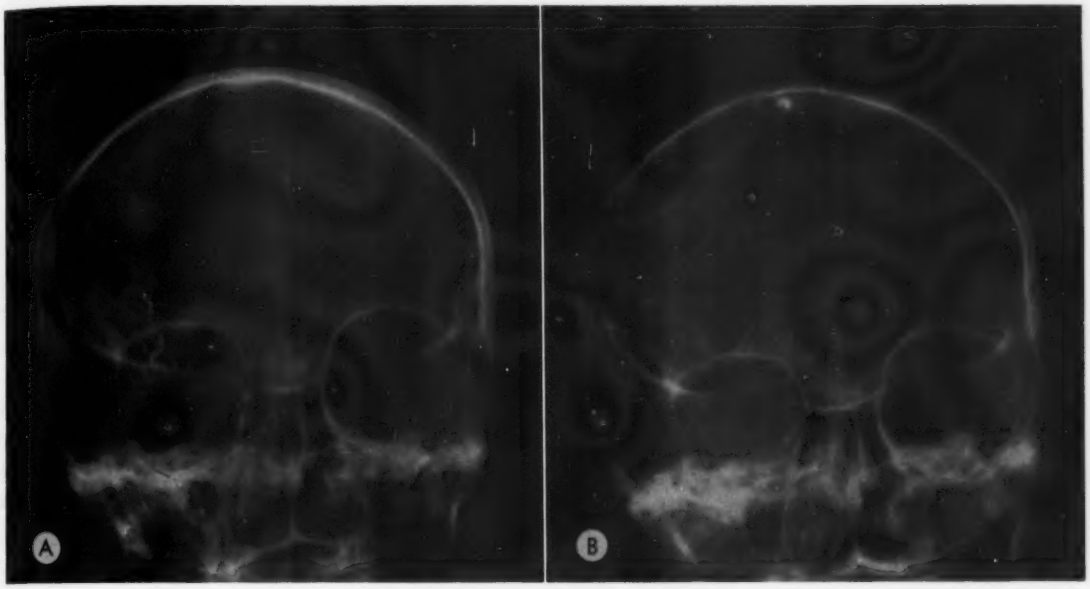

Fig. 2. Relative positions of the anterior cerebral artery and the internal cerebral vein in a patient with a frontal lobe astrocytoma. (*A*) Note marked displacement of the anterior cerebral artery to the opposite side. (*B*) The internal cerebral vein is only minimally shifted.

ting observation of its relationship to the visualized veins along the fixed and unyielding falx. Even when some rotation of the head has occurred, stereoscopy will often provide clear visualization of lateral shift of the internal cerebral vein in relation to the other midline venous structures.

A tumor mass may be localized in the hemisphere from the anteroposterior phlebogram by determining the discrepancy between the displacement of the anterior cerebral artery and that of the internal cerebral vein.

Expanding lesions confined to the frontal lobe will produce maximal lateral displacement of the anterior cerebral artery with

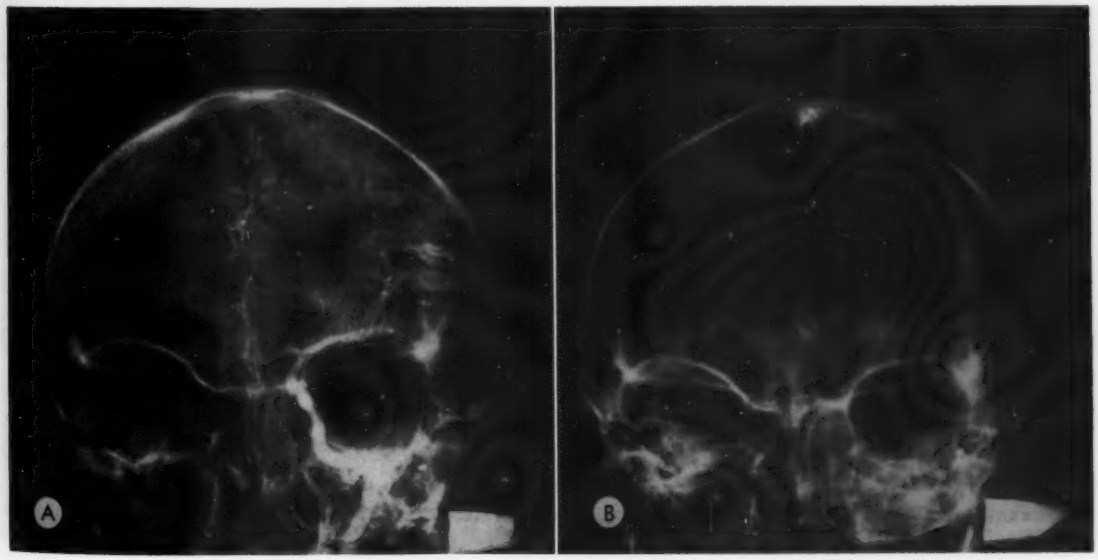

Fig. 3. Large temporal lobe tumor. There is minimal shift of the anterior cerebral artery (*A*) and marked displacement of the internal cerebral vein to the opposite side (*B*).

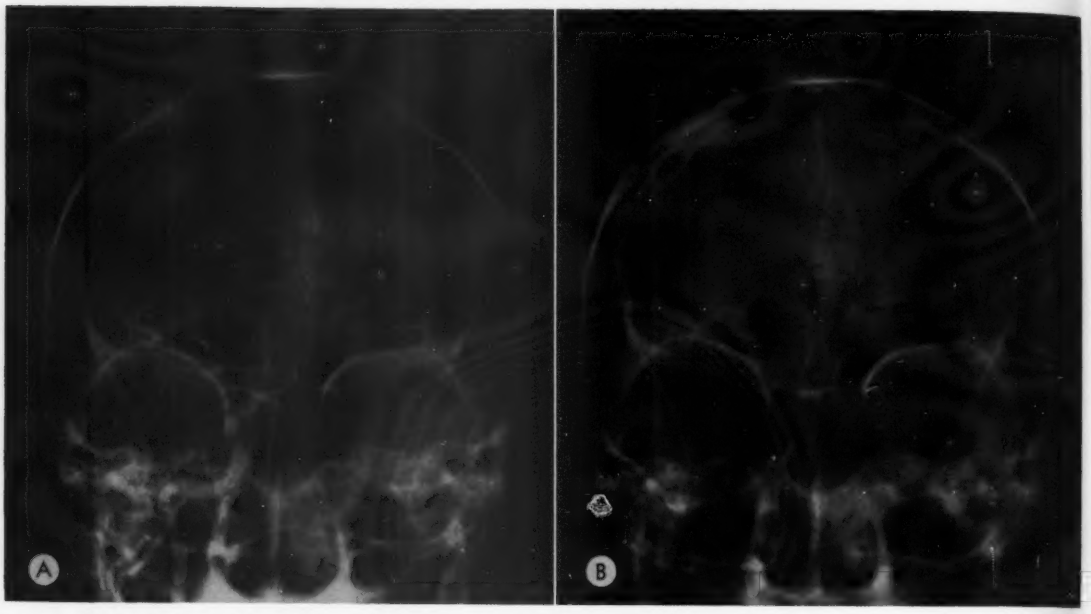

FIG. 4. Metastatic carcinoma involving the right hemisphere with the major lesion situated in the parieto-occipital region. There is equal displacement of the anterior cerebral artery (*A*) and the internal cerebral vein (*B*), probably on the basis of cerebral edema or additional metastatic lesions.

little or no shift of the internal cerebral vein (Fig. 2). A greater degree of lateral shift of the internal cerebral vein associated with marked anterior arterial displacement indicates more posterior extension of the mass.

Maximal lateral derangement of the internal cerebral vein occurs with temporal lobe or midhemispheric lesions. These are usually associated with a lesser degree of displacement of the anterior cerebral artery. The farther posteriorly the lesion is situated,

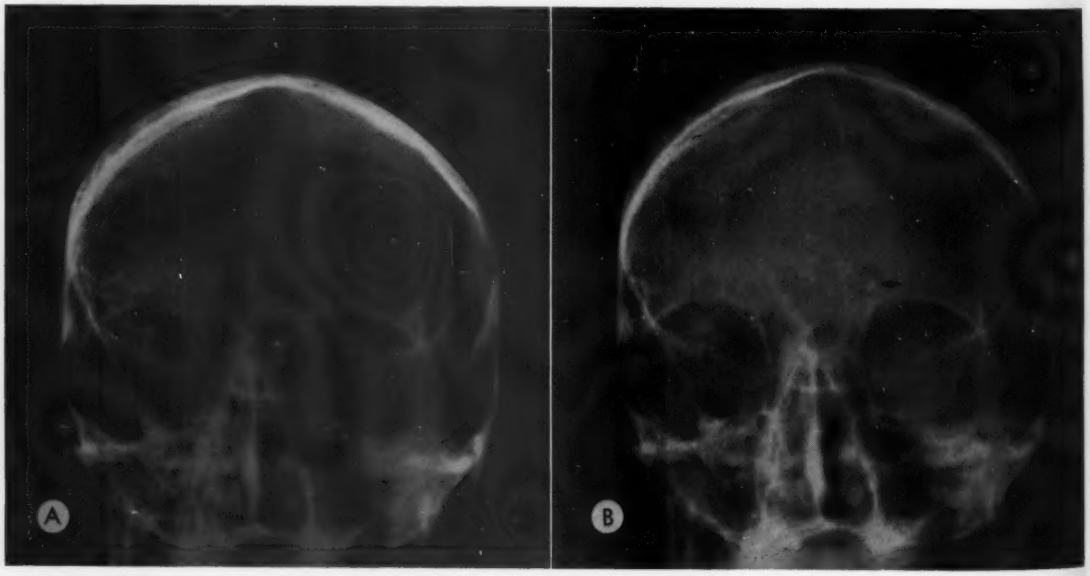

FIG. 5. Large cystic astrocytoma in the right parieto-occipital region. (*A*) The anterior cerebral artery failed to fill in this angiogram. (*B*) Marked displacement of the internal cerebral vein provided the only diagnostic finding in this study.

the greater will be the discrepancy in the degree of displacement of the two vessels (Fig. 3).

Parieto-occipital lobe lesions are situated in the so-called "blind" area for carotid angiography, since they are not usually visualized by injection of the carotid system. An expanding mass in this region will produce lateral displacement of the deep cerebral vein with no lateral derangement of the anterior cerebral artery or distortion of the middle cerebral artery.

Equal displacement of the anterior cerebral artery and the internal cerebral vein may be produced by a small lesion equidistant between these two vessels. This change is more often seen in diffuse involvement of the hemisphere by edema, glioma, or multiple metastatic lesions (Fig. 4).

On the occasional angiogram in which the anterior cerebral artery does not fill, demonstration of lateral displacement of the internal cerebral vein may be the only finding of value suggesting an intracranial mass lesion (Fig. 5).

SUMMARY

The demonstration of lateral displacement of the internal cerebral vein in the anteroposterior projection has been, in our experience, of greatest practical value in the cerebral phlebogram.

This vein because of its anatomic position is more susceptible to lateral displacement than is the calcified pineal gland.

The characteristic patterns of such displacement in frontal, temporal and parieto-occipital lesions are discussed.

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AN AUTOMATIC INJECTOR FOR ANGIOGRAPHY*

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SEVERAL reports of angiographic injecting devices have appeared in the literature. These reports express a desire for simplification of angiographic techniques, yet most of the reports seem concerned only with high pressure injection. Only Rodríguez-Alvarez and Dorbecker[5] reported the pressure rate of flow relationship of their instrument.

The injector described in this paper embodies the following features: (1) it permits completely automatic injection of contrast materials and coordination of roentgen-ray exposures; (2) it eliminates all roentgen-ray exposure to the surgeon and radiologist performing the examination; (3) from calibration data on pressures, it allows known rates of injection; (4) it permits sufficiently high pressure injection in selective angiography to overcome the resistance of long, small lumen conducting systems; and (5) it avoids hazard of hand injury from a broken syringe.

It should be emphasized that one's objective in angiography should be the lowest pressure of injection that produces a satisfactory angiogram. In the pressure-flow rate graphs presented it should be borne in mind that the rate of flow in cubic centimeters per second is the true expression of the jet effect and represents any potential vessel injury. The pressure applied to the conductive system is largely a factor of the resistance of the system. Stirling[7] presents convincing evidence of the safety of aortic injections up to 20 cc. per second.

DESCRIPTION

The injector devised utilizes compressed nitrogen for a source of pressure and is largely constructed from commercially available standard components. The injector (Fig. 1) measures 4 inches by 27 inches, weighs 14 pounds, and when in use rests beside the patient on the roentgenographic table. Though not illustrated, the injector is powered by a size D nitrogen tank on which a reducing valve adjusts the pressure up to 160 pounds per square inch. The tank is connected to the injector by a hose on which a metal tip easily snaps into the female fitting (A). This tip is released by a slight turn of a collar of this fitting.

After assembly and adjustment of the desired nitrogen pressure a solenoid type air valve (B) holds back the gas pressure until released electrically. The thrust of the metal piston (C) is transmitted to the plunger of a standard 50 cc. glass syringe. Since the diameter of the metal piston is 1.5 inches and the diameter of the glass plunger about 1.0 inch, the mechanism has a mechanical advantage of 1.5. Therefore with 100 pounds per square inch nitrogen pressure the liquid pressure within the glass syringe is 150 pounds per square inch. This was found to be the upper limit of safety of standard glass syringes. For nitrogen pressures up to 160 pounds per square inch a special B-D Lehman glass syringe has proved satisfactory.

Equal distribution of pressure on both ends of the glass syringe is achieved by rubber seats. The head of the metal plunger (C) is adjustable to prevent seating of the glass plunger into the bottom of the glass barrel and also to leave a 2.5 cc. dead space to trap the last few drops of air that are difficult to eject from the fluid system. (D) is the roentgen-ray exposure microswitch. This mechanism is adjustable. Microswitch (E) deactivates the solenoid so that the metal piston can be moved backward immediately after the end of the stroke. (F) is a carrying handle, (G) is the 6-prong electrical connection.

In the roentgen-ray control booth are

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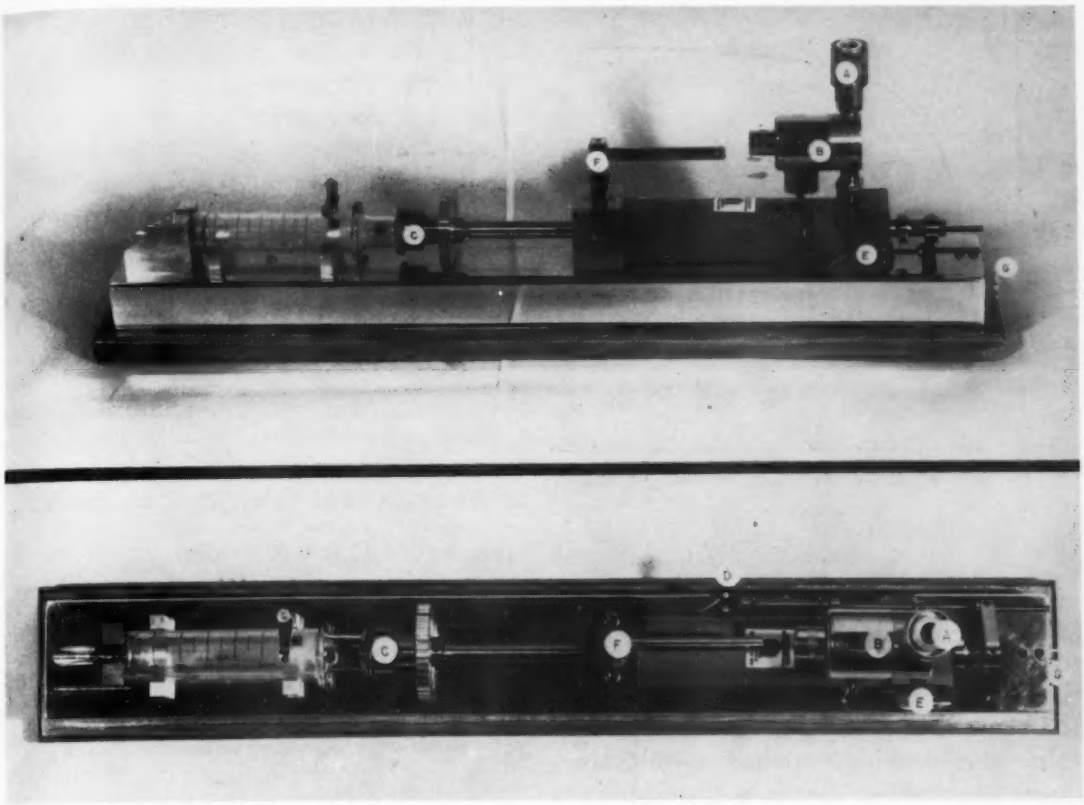

Fig. 1. Photograph of the automatic injector.

two spring loaded switches, marked "Start" and "Stop," and a signal light that indicates that the injection circuit has been activated.

OPERATION

The operating physician fills the 50 cc. syringe with the desired dose of contrast material to be used plus an additional volume equal to the volume of the connecting system and the 2.5 cc. dead space in the syringe. He then places the glass syringe in the cradle of the injector, brings the metal piston in contact with the glass plunger, and steps out of the field of radiation. When the roentgen-ray technician sees the physician place the syringe on the injector, the rotor is activated, and when the physician moves away, the technician activates the injector. The injection and roentgen-ray exposures are automatically completed.

In some techniques a delay in roentgen-ray exposure is desirable. To accomplish this the injector is connected to a delay timer that in turn activates the roentgen-ray control.[6]

PHYSICAL CHARACTERISTICS: ACCELERATION AND TEMPERATURE OF CONTRAST AGENT

In calibrating the injector before clinical use, it became evident that at constant pressure the rate of flow in cubic centimeters per second varied with the volume to be injected (Fig. 2). The rate of flow is nearly constant with 20 cc. or more, but when smaller volumes are used, a more accurate pressure-rate of flow calibration requires a specific calibration depending on the volume. This is of interest to us in cerebral angiography where 6 cc. doses are routinely used.

In order to decrease viscosity of contrast agents, some authors have emphasized warming these solutions before injection. All calibrations presented here were made at room temperature (24° C.)

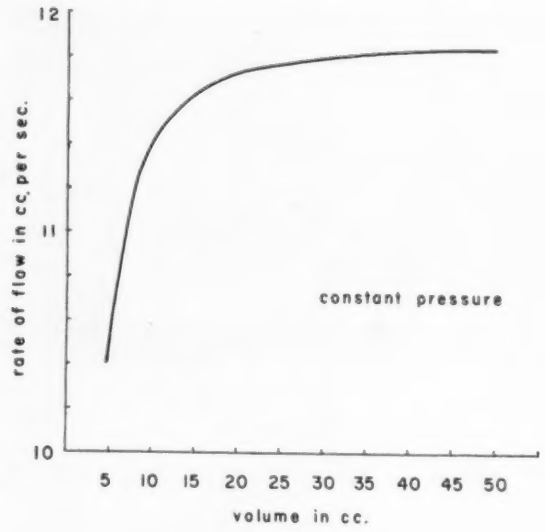

FIG. 2. Acceleration effect.

except for the experiment on temperature effect in Figure 3. It is evident that when the solution temperature is raised from room temperature (A) to body temperature (B) there is only a 5 per cent gain in flow rate. This could be applied to all subsequent calibrations, but is not a significant improvement.

ANGIOGRAPHIC CALIBRATIONS

The connecting systems used are polyethylene tubing (PE-180) and Luer-lok adapters. All percutaneous needles are

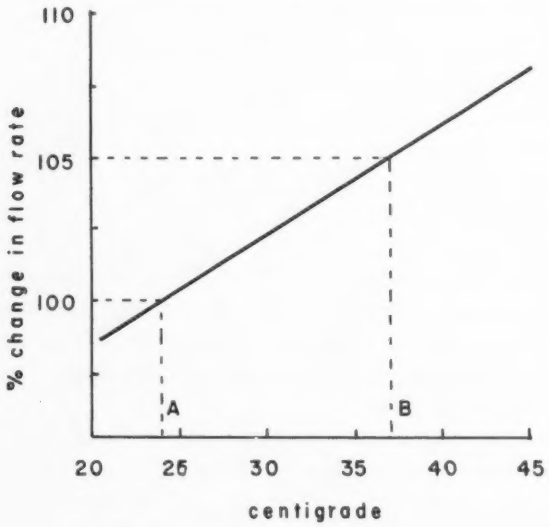

FIG. 3. Temperature effect.

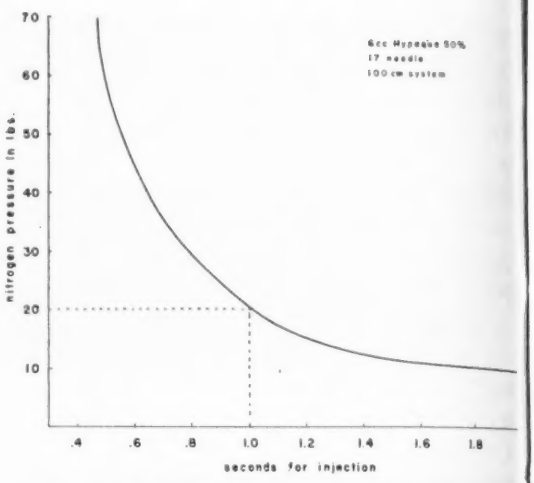

FIG. 4. Calibration for cerebral angiography.

thin walled 17 gauge needles, which have 16 gauge lumens. The injector is calibrated and is used in the following procedures.

Cerebral Angiography. An injection of 6 cc. of 50 per cent hypaque in 0.9 to 1.0 seconds is used. Figure 4 reveals that 6 cc. in 1.0 second is accomplished at 20 pounds pressure. Should another rate of injection become desirable, the new pressure is obtained from the curve. Recalling the findings presented in Figure 2, it is evident that only a limited variation from the 6 cc. volume will follow the data obtained in Figure 4. The length of the connecting system is 150 cm. This is required because the injector is outside the sterile field. The injector syringe is filled by gravity from an intravenous bottle containing hypaque and connected to the system by a T-shaped valve. An automatic stop was added behind the plunger and set for 6 cc. This has been found helpful to the technician in accurately filling the syringe.

Translumbar Aortography. Figure 5 gives the calibration for aortography (and splenography). These curves basically apply to volumes of 20 cc. Comparison of the 70 per cent urokon and 50 per cent hypaque curves reveal an interesting fact about viscosity. Fifty per cent hypaque has been found as radiopaque as a 50 per cent urokon solution. Therefore, 10 cc. of 70 per cent urokon = 14 cc. of 50 per cent hypaque. Referring

to Figure 5 at (a), 10 cc. per second on the 70 per cent urokon curve is equivalent at (b) to 14 cc. per second on the 50 per cent hypaque curve. Therefore, the use of the 70 per cent material has the disadvantage of requiring more pressure to accomplish the same end result. We reserve the use of 70 per cent urokon for angiocardiography and portal venography.

Selective Angiography. In selective angiography using a No. 7 French cardiac catheter the maximum thrust of the injector is employed. The special Lehman glass syringe must be used. A towel may be laid over the syringe as a precaution in case of breakage. In Figure 6*A* the second curve for 50 per cent hypaque is used. At 150 pounds pressure (or 240 pounds thrust) 9 cc. per second is injected. This is equivalent to the minimum desirable dosage rate according to Jönsson *et al.*[3]

Angiocardiography. The curve in Figure 6*B* was prepared by using a 12 gauge Robb-Steinberg trocar. In this procedure minimizing dilution of contrast material is paramount and the use of a 70 per cent contrast agent is logical.

SUMMARY

An automatic injector for angiography has been described and calibration data for various uses have been presented.

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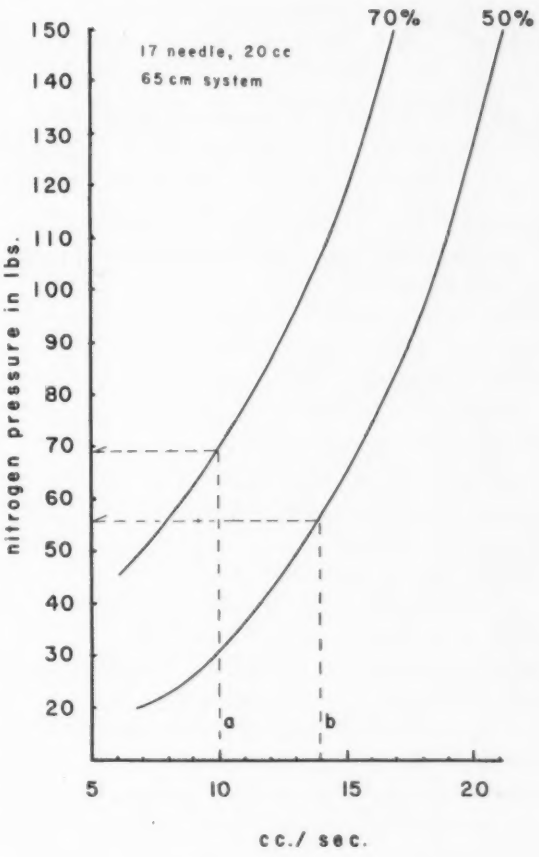

Fig. 5. Calibration for aortography.

I wish to express my deepest appreciation to Mr. Lawrence R. Teeples, Portland, Oregon, for his aid in the design and for his expert craftsmanship in construction of this instrument.

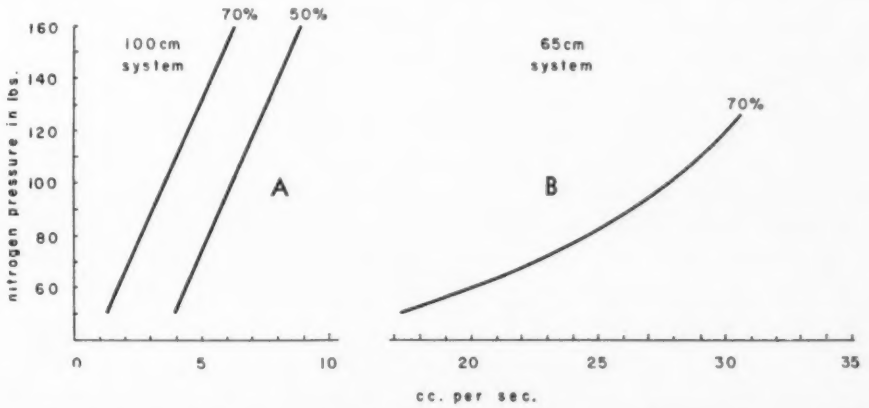

Fig. 6. Calibrations (*A*) for selective angiography with No. 7 cardiac cathether and (*B*) for angiocardiography by using a No. 12, Robb-Steinberg trocar.

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VOL. 80, NO. 6

THE ROENTGENOLOGIC CHARACTERISTICS OF CHONDROMA OF THE LARYNX*

By BRIT B. GAY, JR., M.D.,† SAM A. WILKINS, JR., M.D.,‡ *and* EDWARD P. ENGELS, M.D.§
ATLANTA, GEORGIA

ALTHOUGH chondromas arising in the larynx have distinctive roentgenologic characteristics, only 1 case report has appeared in the English roengenologic literature.[36] The authors have found 118 cases listed in the literature through January, 1957. This number does not include 2 cases of hamartoma of the larynx occurring in early childhood.[4,33] Fifty-three cases were collected by Moore[28] in 1925 and by 1944, McCall *et al.*[27] had brought the total number of cases to 85. The literature has been reviewed and 33 additional cases not included in the above mentioned reviews were found listed. In addition, there are 3 cases diagnosed as chondroma of the larynx which showed spontaneous regression of the tumor after an acute inflammatory reaction in the mass. These cases are not included in the total number of cases since the course in each case suggested a perichondritis.[12,13,42] This communication adds 3 cases of laryngeal chondromas with involvement of the subglottic space, 2 arising from the cricoid cartilage and 1 from the first tracheal ring. An analysis of the roentgenologic findings in those reported cases in the literature having roentgen studies recorded will be given.

PATHOLOGY

Grossly, chondromas of the larynx occur as hard rounded or lobulated submucosal masses which usually are solid and on cut section show a pearly, blue-gray color of normal cartilage. A few show myxomatous degeneration with cystic areas in the tumor. Calcification and ossification occur commonly within these tumors. The size of laryngeal chondromas has varied from 1 to 8 cm.

Laryngeal chondromas have the histologic characteristics of the normal cartilage types, chiefly the hyaline variety. These benign tumors may undergo malignant change and become invasive chondrosarcomas or they may be malignant from their onset. If the benign chondroma is not completely removed, it will notoriously recur with more invasive characteristics accompanying each recurrence.[27] The histologic distinction between chondroma and chondrosarcoma may be difficult even to the experienced pathologist.[37] Of the reported chondromatous tumors of the larynx, all have shown benign histologic characteristics except 13.

Frenzel[12,13] and Unterberger[42] have reported 3 cases diagnosed as laryngeal chondroma which spontaneously regressed following a severe inflammatory reaction (perichondritis). Necrosis and decrease in size of a chondroma thus may occur in response to an associated inflammation.

SITE OF ORIGIN

The cricoid cartilage is the most common site of origin, being involved alone or in combination with other cartilages in about 63 per cent of the cases. The thyroid cartilage is the next most common site of origin, being involved alone or in combination with other cartilages in 35 per cent. Chondromas arising in the epiglottis and arytenoid cartilages are rare. Involvement of multiple cartilages occurred in about 25

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per cent of cases and single cartilage involvement in about 75 per cent. Kelley[23] reported a case arising in the vocal cord and noted a second case reported by Smith.

CLINICAL FINDINGS

Most patients with laryngeal chondromas have been between the ages of forty and sixty years. The review of McCall *et al.*[27] noted age variations from fifteen to eighty-one years at the time of diagnosis. Males are more likely to develop a laryngeal chondroma; Moore[28] reported a 4:1 ratio between male and female. Twenty-four of 30 collected patients of McCall *et al.* were males.[27]

Hoarseness is usually the earliest symptom. As the tumor enlarges and the airway is encroached upon, cough, dyspnea, stridor, and aphonia may develop. Dysphagia may result from esophageal compression. Pain may be present in the more invasive tumors or if mucosal erosion over the tumor occurs. Hemoptysis seems to be uncommon in the reported cases. Symptoms tend to develop and progress slowly and the patient may minimize the symptoms for a long time. When the tumor becomes large, a minimal respiratory infection may be sufficient to produce edema with resulting acute laryngeal obstruction, necessitating emergency tracheotomy. Those tumors which grow outwardly and do not encroach upon the laryngeal lumen may cause no symptoms other than that of a slowly expanding indurated mass in the neck arising from the thyroid cartilage.

Laryngoscopy will usually reveal the presence of a round submucosal mass covered by an intact mucous membrane. Most often the mass is subglottic and posterior in position since the greatest number arise from the laryngeal surface of the posterior cricoid plate. Smaller tumors may appear merely as vague mucosal swellings and a definite mass may be difficult to define. Figi[11] has stressed the finding of prominent blood vessels in an otherwise normal mucosa covering a smooth sessile mass as being characteristic of chondroma. Ulcerations of the mucous membrane over the tumor are not common but may occur. Larger chondromas will displace and distort the vocal cords and interfere with motility, but true paralysis is not usually present.

Biopsy of a laryngeal chondroma may be difficult with direct laryngoscopy since these tumors are quite hard.

The larger chondromas, particularly those of thyroid cartilage origin, can be palpated as very firm, smooth, or lobulated masses which move with the larynx and are not attached to the overlying skin.

ROENTGENOLOGIC FINDINGS

Figi[11] was the first author to publish roentgenograms on cases of laryngeal chondroma. The present authors have tabulated 26 cases from the literature in which the roentgenologic changes were described.[3,7,11,12,14,17,19–22,25,29,30,32,35,36,38,40] Six of these patients had tumors arising from the thyroid cartilages, 2 from the thyroid and the cricoid cartilages, 2 from the arytenoid cartilages, and 16 from the cricoid cartilage. From these published observations and from the experience with our 3 cases, we believe that certain patterns can be established for the roentgenologic diagnosis of laryngeal chondroma.

In general, laryngeal chondromas present roentgenologically as smoothly outlined masses which bulge into the airway of the larynx. Calcification in the mass is common and was specifically mentioned in 18 of 26 cases in which roentgenograms were described. Two of the authors' 3 cases contained calcium deposits. The calcification usually appears as multiple small areas of stippled density, but rarely may show a fine linear pattern as in the chondrosarcoma reported by Sirota and Hurwitz.[38] The calcification may be very extensive throughout the tumor and the whole mass may appear solidly calcified as in the case of Ryan and Zigmor.[36]

The most common location for laryngeal chondroma is the posterior aspect of the subglottic space since most of the tumors arise from the endolaryngeal surface of the

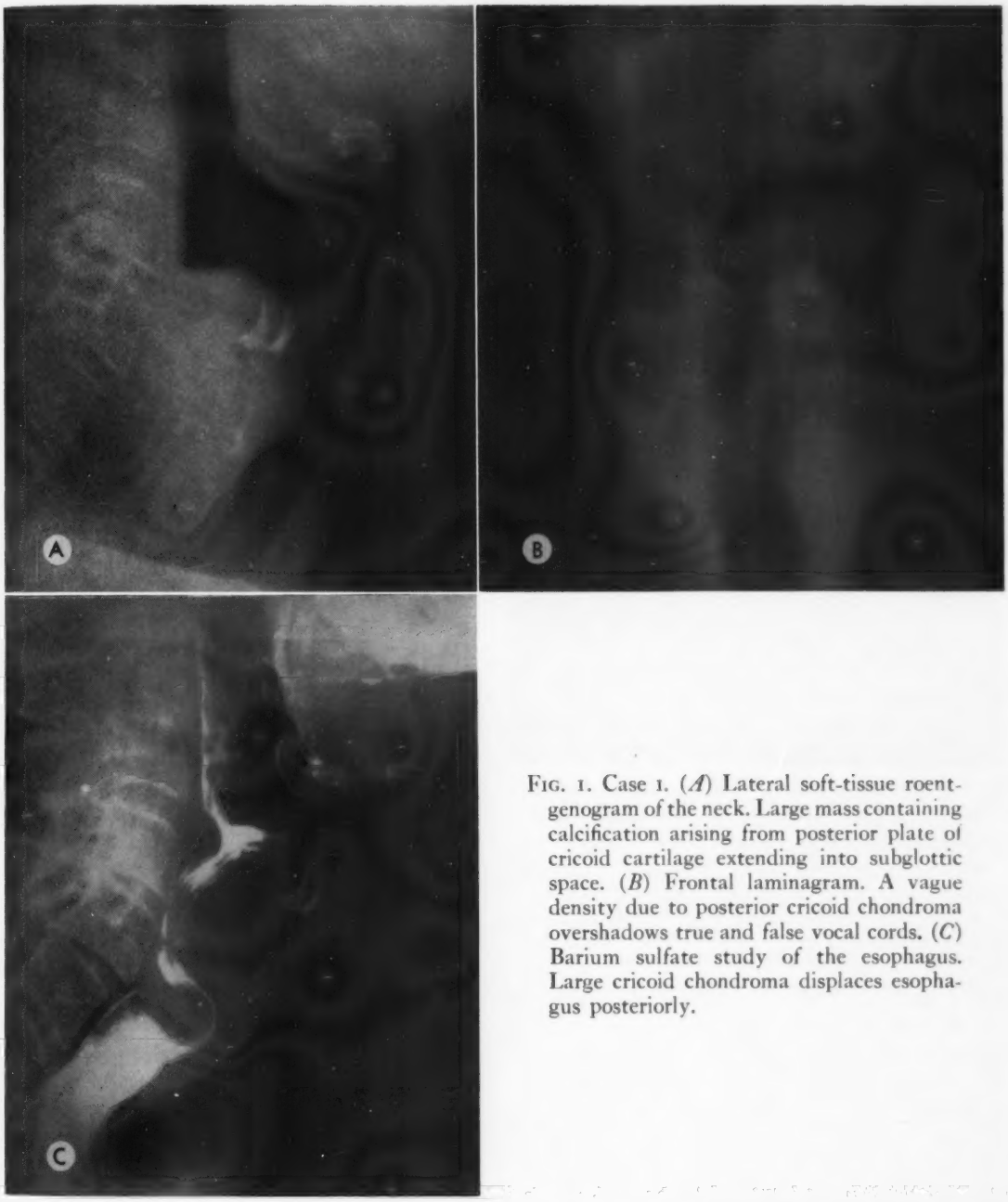

Fig. 1. Case 1. (*A*) Lateral soft-tissue roentgenogram of the neck. Large mass containing calcification arising from posterior plate of cricoid cartilage extending into subglottic space. (*B*) Frontal laminagram. A vague density due to posterior cricoid chondroma overshadows true and false vocal cords. (*C*) Barium sulfate study of the esophagus. Large cricoid chondroma displaces esophagus posteriorly.

posterior plate of the cricoid cartilage. The lateral roentgenogram of the neck reveals a soft tissue density impinging upon the airway of the larynx below the level of the vocal cords (Fig. 1*A*). The lesion may vary in size from a slight convexity of the endolaryngeal margin of the posterior cricoid plate to an extensive endolaryngeal mass with only a small air column in the anterior portion of the larynx. In some cases, there may be complete obliteration of the air column in the larynx. In the frontal projection, best seen on the anteroposterior laminagram (Fig. 1*B*), the mass may be centrally placed and appear as a density superimposed over the vocal cords. Roentgenoscopy will show normal or limited motion of the vocal cords depending on the size of

FIG. 2. Chondroma of cricoid cartilage as seen at operation after incision anteriorly of thyroid and cricoid cartilages and first tracheal ring. The posterior laryngeal mucosa has been incised exposing chondroma. Surgeon's finger is inserted into origin of esophagus. An endotracheal tube is noted inferior to tumor.

the tumor and the degree of compression of the vocal cords. Fixation of the vocal cords by the tumor is not so common in laryngeal chondroma as with malignant epithelial growths arising from the vocal cords. An esophagram is necessary to show the relation of the tumor to the esophagus. In larger tumors the esophagus may be compressed and displaced posteriorly (Fig. 1*C*). The presence of barium sulfate within the esophagus will also aid in evaluating the size of the tumor.

In some cricoid chondromas the tumor may not be in the midline, but rather project from one side of the subglottic space as in our Case III (Fig. 8).

The next most common roentgenologic pattern is that of a soft tissue density arising unilaterally in the region of the thyroid cartilage and bulging into the laryngeal airway (Fig. 3). The pyriform sinus on the involved side is compressed and obliterated when demonstrated by laminagraphy or barium sulfate ingestion. The aryepiglottic fold on the involved side bulges convexly into the laryngeal vestibule along with medial displacement of the true and false vocal cords. The laryngeal ventricle may be obliterated. With those chondromas arising from the thyroid cartilage and which expand externally, the intrinsic structures of the larynx may be normally defined and the tumor will be shown roentgenologically only if it contains sufficient calcification.

No roentgenograms have been published in cases in which the chondroma arose from the epiglottis. Dominik[9] has recently reported the clinical findings in a case of epiglottic chondroma. One drawing of a specimen is reported by Moore.[28] In this case, the tumor arose from the base of the epiglottis and bulged into the airway. Figure 4 shows a sketch of a hypothetical roentgenogram as might be expected in such a case. The normal contours of the epiglottis would be lost and if calcification was present, this would aid in distinguishing the lesion from epithelial tumors arising from the epiglottis.

Chondromas arising in the arytenoid cartilages are also rare. Only 2 cases with roentgenograms reproduced are available in the literature for tumors in this location.[12,22] These lesions expand into the posterior aspect of the vestibule and produce deformity and thickening of the adjacent aryepiglottic folds (Fig. 5). Calcifications were present within the tumor in both of the reported cases.[12,22]

Chondromas arising in the vocal cords are quite rare with only 2 cases reported.[23] Theoretically, in this location the mass would produce localized swelling on one vocal cord which could not be distinguished

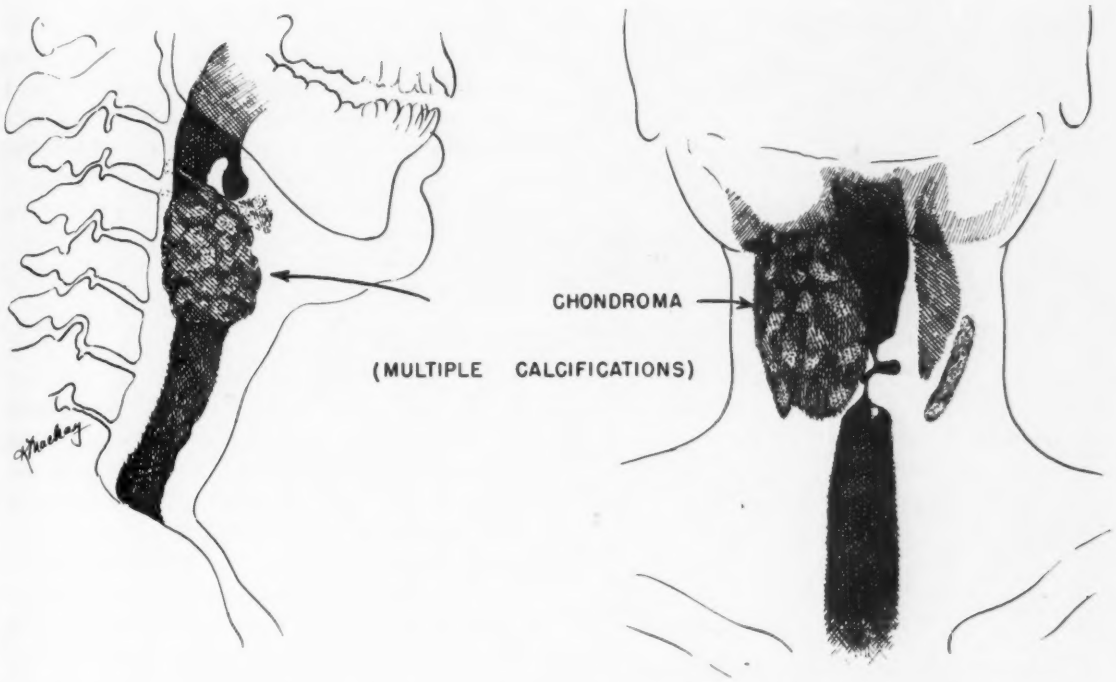

Fig. 3. Artist's drawing of hypothetical roentgenogram of a chondroma arising from the thyroid cartilage.

from a vocal cord polyp or other papillary mass unless calcifications were present within the tumor.

ROENTGENOLOGIC DIFFERENTIAL DIAGNOSIS

Chondromas of the larynx are rare, and whenever a laryngeal mass is seen roentgenologically one will more likely consider squamous cell carcinomas which frequently may extend subglottically and simulate chondroma. Calcification within epithelial tumors is unusual; thus, the presence of calcification is helpful in differential diagnosis. Squamous cell carcinoma arising in the vocal cord and extending subglottically will usually have an irregular contour whereas chondromas are more often smoothly outlined. Carcinomas tend to be more anteriorly placed whereas cricoid chondromas arise posteriorly.

Those chondromas which are not calcified and which arise from the thyroid cartilage may be indistinguishable from carcinomas arising in the floor of the pyriform sinus. If destruction of the thyroid ala can be demonstrated by a frontal laminagram, the diagnosis of chondroma can be eliminated from consideration. If extensive calcifications are present, carcinoma can be excluded.

New and Erich[31] have described 6 rare cases of adenocarcinoma of the larynx. These tumors usually are subglottic, slow growing, and may simulate cricoid chondroma as to location, but apparently do not frequently calcify. Other lesions such as inflammatory tumors, amyloidosis, tuberculomas, fibromas, cysts, neurogenic tumors, and lipomas may present as submucosal laryngeal masses which because of location may simulate chondroma. Biopsy is always required to confirm the roentgenologic diagnosis.

Two cases of laryngeal hamartoma have been reported.[4,33] These are mixed tumors containing cartilage, fibrous tissue, fat, and epithelial tissue and are of developmental origin. The 2 reported cases occurred in young children and are not considered the

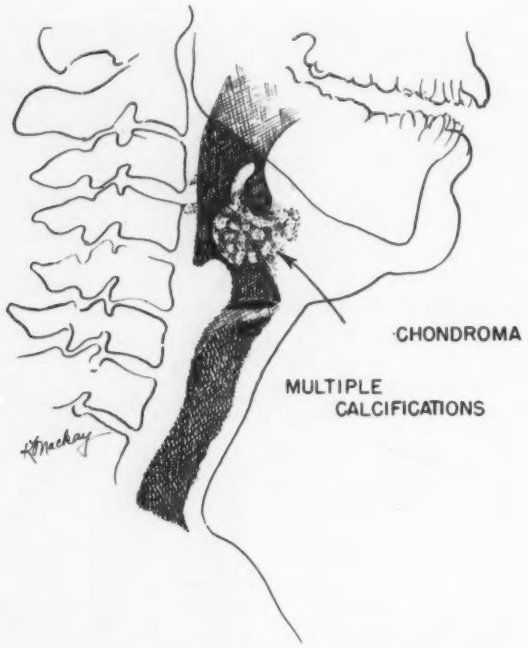

FIG. 4. Artist's drawing of a hypothetical roentgenogram of a chondroma arising from the base of the epiglottis.

same as chondromas developing later in life.

Another condition which may be associated with cartilaginous tumors of the larynx is that of tracheopathia osteoplastica.[12] This condition primarily involves the trachea, but rarely there may be secondary involvement of the larynx. In this lesion, metaplastic bone and cartilage is found in the mucosa and submucosa of the larynx and trachea. Calcifications occur in these masses which are seen in the subglottic space. Associated extensive involvement of the trachea will differentiate this condition from primary laryngeal chondroma.

TREATMENT

Treatment of chondroma of the larynx is invariably surgical. If the lesion has become extensive, laryngectomy may be the only choice. In smaller tumors, laryngofissure with excision of the tumor is the procedure of choice (Fig. 2). Laryngectomy can be resorted to if recurrence is noted. If the tumor is definitely invasive, all authors recommend total laryngectomy.

REPORT OF CASES

CASE 1. This seventy-seven year old white female had been apparently in good health until three years before admission when she noted the gradual onset of hoarseness. This had been diagnosed as "chronic laryngitis." The day before admission her physician noted a questionable area in the subglottic space, because of which he referred the patient to the Emory University Clinic.

Local examination of the neck failed to reveal any mass in the region of the larynx. No lymphadenopathy was noted. The remainder of the physical examination was essentially negative. Mirror laryngoscopy indicated normal vocal cord motility. There appeared to be considerable subglottic edema, but a distinct tumor was difficult to define.

Roentgenologic examination. Lateral soft tissue roentgenograms of the neck (Fig. 1*A*) revealed a mass containing calcifications bulging into the posterior aspect of the laryngeal airway primarily in the subglottic region. The airway was narrowed anteriorly. Roentgenoscopy with the image amplifier showed normal motility of the vocal cords. Frontal laminagrams (Fig. 1*B*) demonstrated a density ob-

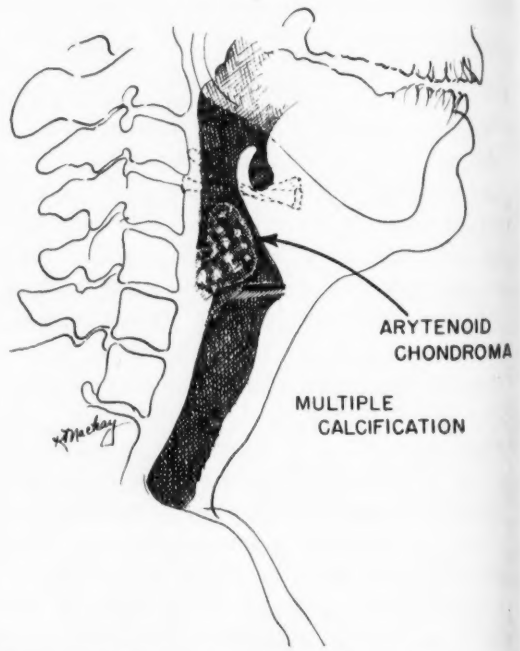

FIG. 5. Artist's drawing of a hypothetical roentgenogram of a chondroma arising from an arytenoid cartilage.

Fig. 6. Case 11. Lateral roentgenogram of the neck. A large calcified mass bulges into the subglottic and tracheal airways with deviation of the tracheal airway posteriorly. Small insert at lower right shows roentgenogram of excised chondroma arising from first tracheal ring.

scuring the detail of the airway and vocal cords. With barium sulfate ingestion (Fig. 1*C*), the proximal cervical esophagus was shown to be displaced posteriorly.

Under local anesthesia a midline incision was made and a tracheotomy tube inserted into the upper trachea. The midline incision was extended from the sternal notch to a point just above the hyoid bone. The thyroid and cricoid cartilages were divided in the midline along with the first two tracheal rings. With the larynx opened anteriorly there could be seen a smooth round well-encapsulated pearly mass arising from the region of the posterior plate of the cricoid cartilage. This bulged forward into the larynx just below the vocal cords, producing a near obstruction to the airway.

The tumor measured approximately 5 cm. in its greatest dimension. After an incision was made in the posterior mucosa of the larynx, delivery of the tumor was facilitated by a finger of the operator inserted into the esophagus from above the interarytenoid membrane (Fig. 2). The chondroma was shelled out of its bed extraperichondrally and finally removed piecemeal but cleanly. It was possible to preserve the intrinsic muscles and nerves of the larynx because of the midline approach. The patient tolerated the operative procedure well and was sent to the ward in good condition.

Pathology. Received in a fresh state were several fragments of light pinkish-gray tissue, the largest of which measured 2.5 cm. in diameter. The tissue was very friable, and had the consistency of cartilage. Microscopic examination revealed normal cartilage which showed some activity in places, but which was completely encapsulated and showed no evidence of

FIG. 7. Case III. Lateral roentgenogram of neck (retouched) showing large mass in posterior subglottic space with nearly complete obliteration of airway anteriorly. Tracheotomy tube is present.

malignancy. Diagnosis: Chondroma, cricoid cartilage.

Postoperatively on the second day, the patient showed electrocardiographic changes of a myocardial infarction. Otherwise no complications were noted. She was discharged home still wearing her tracheotomy tube. Four months following surgery the patient was beginning to talk and tolerate occlusion of the tracheotomy tube.

CASE II. This forty-six year old machinist first noticed a small lump in the right anterior portion of his neck approximately three years before admission. This small lump grew very slowly for two years and caused no symptoms. During the year before admission it enlarged more rapidly. Three months prior to admission, he experienced stridor and dyspnea especially when turning his head toward the left. He first noted hoarseness one month prior to admission. He had no dysphagia, weight loss, or hemoptysis.

Physical examination revealed normal temperature, pulse, and respiration with blood pressure of 248/102. The patient had obvious dyspnea and stridor but no cyanosis. Local examination of the neck disclosed a 3 by 5 cm. firm smooth mass in the region of the lower pole of the right thyroid lobe, but no regional lymphadenopathy. The remainder of the physical examination was negative except for slight cardiomegaly and an aortic systolic murmur.

Roentgenologic examination. A lateral soft tissue roentgenogram (Fig. 6) revealed a large mass bulging anteriorly into the subglottic space of the larynx and proximal trachea with marked narrowing of the tracheal airway. Several calcifications were noted in the mass.

Immediate surgery was done with N_2O and O_2 anesthesia. Tracheotomy was performed just below the cricoid cartilage and right hemithyroidectomy was begun. The smooth whitish tumor was seen presenting from the anterior surface of the trachea and found to extend into the tracheal lumen from the anterior wall, so as to require removal of the anterior two-thirds of the first two tracheal rings. The skin was sutured to the margins of the tracheal defect and a tracheotomy tube inserted.

Pathologic examination revealed a bilobed firm white tumor weighing 44 gm. containing portions of two tracheal rings. Areas of calcification were present. Diagnosis: Chondroma of trachea with tendency to malignancy in intratracheal portion.

The postoperative course was uneventful.

CASE III. This fifty-nine year old white male was first admitted to the Atlanta Veterans Administration Hospital in March, 1954 for a bleeding duodenal ulcer. The second admission of February 9, 1956 was for recurrent bleeding of the known duodenal ulcer. On the second admission the hemorrhage was so severe that an emergency hemigastrectomy and vagotomy were performed. When an attempt was made to pass an endotracheal tube prior to laparotomy, an obstruction was met. It was felt by the anesthesiologist that a left vocal cord paralysis was present. A tracheotomy was done and no definite diagnosis of the laryngeal obstruction was made at this admission. After the patient recuperated from the abdominal surgery, he was discharged from the hospital still wearing the tracheotomy tube. He returned August 20, 1956 for further treatment of the laryngeal obstruction.

Indirect laryngoscopy showed the left vocal cord to be immobile. The right vocal cord was normal. The glottis appeared to be insufficient for breathing. The obstruction was thought to

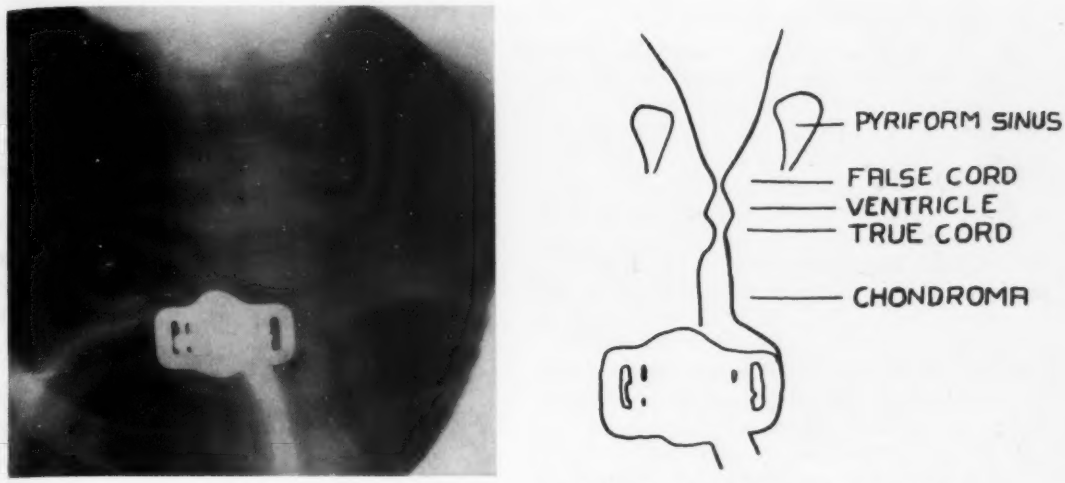

FIG. 8. Case III. Frontal laminagram reveals left sided subglottic mass due to cricoid chondroma. Diagram of laminagram is noted on right.

be in the cricoid region. With a laryngeal mirror a definite mass could not be seen.

Three days later a direct laryngoscopy was done under general anesthesia. The glottis appeared normal. The right vocal cord moved normally. The left vocal cord did not move well; it did not appear paralyzed but rather mechanically inhibited. Immediately below the left vocal cord and presenting from posteriorly, there appeared to be a smooth mass which more than half-filled the subglottic space below the cords. It felt very firm. By manipulation, a No. 5 bronchoscope could be passed through the larynx into the trachea without difficulty. The clinical impression at this time was chondroma, probably arising from the left side of the thyroid cartilage.

Roentgenologic examination. A lateral roentgenogram of the neck (Fig. 7) revealed a tracheotomy tube within the proximal trachea. A large mass was seen arising in the posterior part of the larynx extending primarily into the subglottic space. Only a thin line of radiolucency representing the airway could be seen anterior to the mass. A frontal laminagram (Fig. 8) disclosed the mass to be arising on the left side of the larynx in the subglottic space. No calcifications in the mass could be noted.

The patient agreed finally to surgery, and on September 18, 1956, a submucous resection of a chondroma arising from the cricoid cartilage on the left side was performed.

Pathology. Specimen consisted of a single nodular segment of tissue having a gross appearance of cartilage. The specimen measured 2 by 1.3 by 1.7 cm. The surface made by cutting was firm, white and smooth, but in one region there was a fairly well circumscribed area of tissue which appeared to be softer and slightly mucoid in appearance. Microscopically, well differentiated cartilage cells were seen. Diagnosis: Chondroma, cricoid cartilage.

The patient retained the tracheostomy until September 12, 1956, at which time all tubes were removed. The patient was discharged with tracheostomy opening, which was left to close at home.

SUMMARY

Chrondromas of the larynx are rare tumors but present rather distinctive characteristics roentgenographically. One hundred and eighteen cases have been found listed in the literature; to this number the authors add 3 cases involving the subglottic space.

Chondromas of the larynx most often arise from the cricoid cartilage and usually present as a subglottic mass which is posteriorly placed, bulging into the laryngeal airway. Most of these tumors will contain considerable calcium deposits. They are usually smoothly outlined. Those tumors arising from the thyroid cartilage will deform one side of the larynx with obliteration of the pyriform sinus and deformity of the aryepiglottic fold of the same side.

Treatment is always surgical.

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CALCIFICATION IN PAPILLARY CARCINOMA OF THE THYROID

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ALTHOUGH abnormal calcifications in the neck have long been of value to the roentgenologist in the diagnosis of calcified lymph nodes or calcified vessels, calcifications within the thyroid gland have generally been interpreted as representing a degenerative benign nodule. More detailed attention to the nature of the thyroid calcifications will aid in establishing a specific diagnosis.

Calcifications representing psammoma bodies have been recognized histologically and roentgenographically in meningiomas and in certain tumors of the ovary and pancreas.[2,3] Psammoma bodies have been demonstrated histologically in papillary adenocarcinoma of the thyroid, and their presence can be utilized in roentgen diagnosis.

The material for this study consists of 53 patients seen in Barnes Hospital in a ten year period. All had histologically proved papillary carcinoma of the thyroid. Twenty-eight of these 53 patients had roentgenograms which included the neck. The examination consisted generally of a chest roentgenogram, but, occasionally, detailed films of the neck were available. Chest roentgenograms are not generally adequate for evaluation of thyroid calcification. On histologic examination of the sections of the surgical specimens from these 58 patients, 12 had psammoma bodies within the papillary carcinoma. Of the 12 patients with psammoma bodies recognizable in histologic sections, 3 patients had roentgenographic evidence of calcifications in the thyroid thought to be typical of psammoma bodies. In 1 a preoperative diagnosis of papillary carcinoma of the thyroid was made, based on the finding of "typical" calcifications within the area of the thyroid tumor.

REPORT OF A CASE

A fifty-six year old white male entered Barnes Hospital with a history of an enlarged thyroid since early childhood. The mass had been noted to increase progressively in size during the past three years. The patient was otherwise asymptomatic.

At physical examination the trachea was noted to be displaced to the right by a large, smooth, soft movable mass considered to be an enlarged thyroid gland. The right lobe of the thyroid was barely palpable. Chest roentgenograms were normal except for a soft tissue mass displacing the trachea, and soft flocculent calcifications within the mass (Fig. 1).

Laboratory examinations were essentially negative.

At operation, a large cystic mass involved the left lobe of the thyroid. The right lobe of the thyroid was normal to palpation. A hemithyroidectomy with removal of the isthmus was performed.

The specimen weighed 225 gm. The cut surfaces of the lobe contained a central fibrous core from which extended numerous papillary branches giving a snowflake appearance. The spaces between the papillary fronds were filled with thin, sanguineous fluid. In the spaces, firm tiny yellow bodies were found which suggested calcification (Fig. 2). Microscopic sections were characteristic of well differentiated papillary

FIG. 1. Apical roentgenogram of chest. There is displacement of the trachea and thyroid cartilage by a thyroid tumor. Within this tumor are punctate calcifications (upper arrow) and a larger conglomeration of psammoma calcifications (lower arrow).

FIG. 2. Roentgenogram of the specimen. There are small calcifications resulting from fusion of psammoma bodies and larger calcifications which are the result of conglomeration of the fused psammomas.

carcinoma of the thyroid with a peripheral zone of fibrous tissue and compressed thyroid parenchyma. Numerous calcified psammoma bodies were seen (Fig. 3).

DISCUSSION

The origin and natural history of psammoma bodies are uncertain. They are found in the acini as well as the stroma of certain tumors. Most observers feel that they represent degenerative changes with progressive fibrosis, hyalinization, and calcification of the tip of the fibrous stalk within the tumor. The psammoma bodies then may become independent of the tumor and may be spread by lymphatics into the adjacent portions of the gland or even into regional lymph nodes.[2,7]

In meningiomas and tumors of the ovary and pancreas, the roentgen characteristics of psammoma bodies have been adequately described in the past.[2,3,6,8] Psammoma bodies apparently do not occur in the normal thyroid gland,[1,4,5,9] but only in association with papillary carcinoma of the thyroid.[1,7] In one case described by Crile and Fisher[1] biopsy of the thyroid gland revealed only chronic inflammatory changes and psammoma bodies. Because of the lack of response to treatment and the finding of psammoma bodies a second operation was performed. Histologic study of additional tissue disclosed the papillary carcinoma.

The single psammoma body is so small (50–75 μ) that it cannot be seen on the roentgenograms. Visualization of the tumors with psammoma bodies on roentgenograms may occur in one or a combination of three ways: (1) With numerous psammomas close together, a diffuse rather homogeneous increase in density of the tumor may result. (2) In some cases the psammoma bodies may be clumped to give the picture of multiple pin-point flecks of calcification. (3) If the psammoma bodies fuse to form calcium spicules, sharp, discrete, irregular calcific masses are seen.[2] The case presented here represents a combination of all three types.

There may be several reasons why these papillary adenocarcinomas of the thyroid are not demonstrable roentgenographically. There may be no psammoma bodies present in the tumor (less than 50 per cent of our cases had them on histologic study). The psammomas may be inadequate in number and widely separated, or overlying shadows may obscure them.

Extrathyroid calcifications, such as calcified carotid arteries and calcified lymph nodes, can be easily distinguished from calcified psammomas. Calcifications within degenerated thyroid nodules are larger, more irregular, localized, more dense, and quite different from the psammoma calcifications. The most difficult differentiation that arises is that of artefacts, either in the screen or produced in the processing of the roentgenogram. These may cause images which simulate and may be indistinguishable from psammoma body calcification.

FIG. 3. Histologic section of tumor. There are multiple psammoma bodies clumped within a stalk of the papillary carcinoma.

Thus, scrupulous technique and processing are necessary.

If possible, the surgeon should know prior to operation that the patient has a malignant lesion. This is particularly true of papillary carcinoma of the thyroid, as the prognosis is better and the operative approach is different from other malignancies of this gland in that an extracapsular total thyroidectomy should be performed.[7,10]

When tumors of the thyroid are suspected, detailed roentgen study of the neck is advisable. This optimally should consist of anteroposterior, lateral and oblique views using soft tissue technique.

SUMMARY

1. Psammoma body calcifications occur in association with papillary carcinoma of the thyroid gland.

2. These calcifications differ from calcifications in degenerated nodules and in septa of multinodular thyroids.

3. Recognition of calcified psammomas by roentgenograms is diagnostic of papillary carcinoma of the thyroid.

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ROENTGENOGRAPHIC DEMONSTRATION OF A HYPOPHYSIAL SUBARACHNOID SPACE*

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MOST textbooks of anatomy follow the conceptions of Wislocki[5] when describing the meningeal relations of the hypophysis. He found in studies on a 160 mm. human fetus that the subarachnoid space formed a collar around the infundibulum and, in his words: "In the subsequent course of development, the subarachnoid space never surrounds the body of the pituitary within the sella turcica."

Prior to this work, Hughson[2] and Bailey[1] claimed that the hypophysis was invested by all three meningeal layers, Bailey even feeling that the layer of pia surrounding the epithelial lobe continued into the region of separation between the pars intermedia and the neural lobe.

Schaeffer[4] in pertinent and forgotten observations noted that the foramen diaphragmatis sellae varied from a small aperture to a relatively huge infundibular foramen with a mere peripheral rim of dura. "In the latter case," he mentions, "the overlying arachnoid forms a loose tissue over the hypophysis within the confines of the diaphragmal foramen. . . . The fact, however, remains that the foramen in the diaphragma sellae frequently is very large, allowing the subarachnoid spaces to come into contact with the hypophysis and the perihypophysial tissues within the aperture of the diaphragma."

The author has frequently observed a wide disparity between the size of the infundibulum and the diaphragmal aperture in many postmortem examinations.

In one such examination (Case A55–117, Ancker Hospital, St. Paul, Minn.), a purely intrasellar meningioma 1.5 cm. in diameter was found which grossly appeared to be a pituitary tumor. The diaphragma sellae was intact though bulged up from below. Sections (Fig. 1) showed the typical whorls of fibrous tissue characteristic of meningeal fibroblastoma invading the dural capsule adjacent to the anterior lobe. Intrasellar arachnoidal membrane or rests might explain the peculiar and rare site of the tumor since it is felt that meningeal fibroblastomas have an arachnoidal derivation.

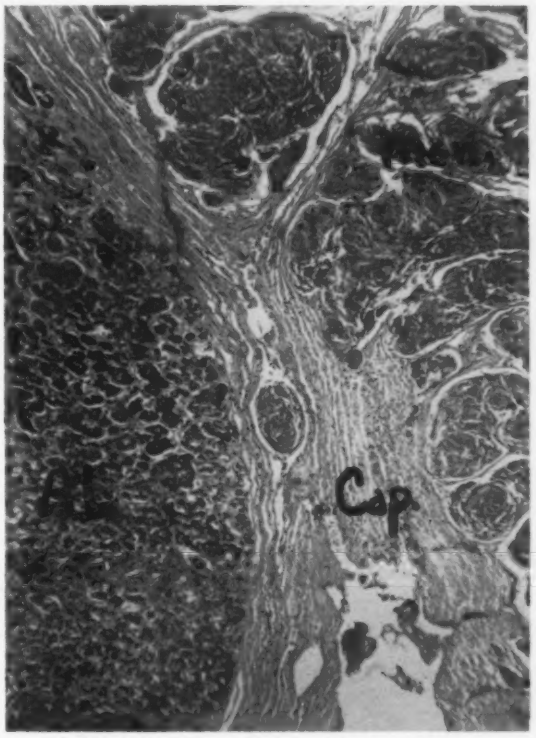

FIG. 1. Typical fibrous whorls of meningioma shown invading the capsule of the anterior lobe of the pituitary gland. Al, anterior lobe; Cap, capsule; Men, meningioma.

Radiopaque oil sometimes is inadvertently introduced into the cranial subarachnoid cisterns during myelography. This happened in a forty year old man while this procedure was being done at another institution. A year later, he suddenly developed an acute nonspecific labyrinthitis which was attributed to an

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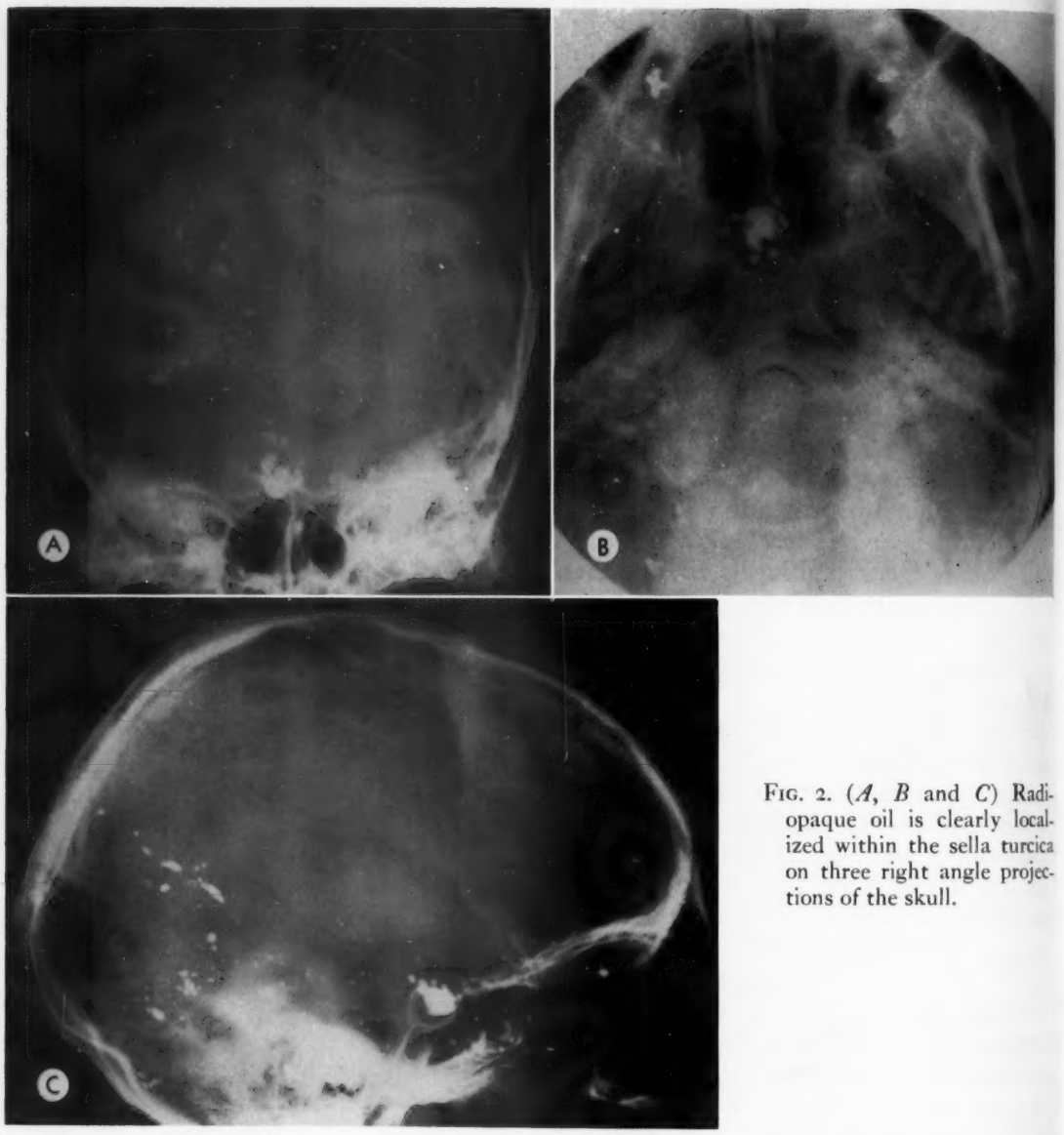

FIG. 2. (*A*, *B* and *C*) Radiopaque oil is clearly localized within the sella turcica on three right angle projections of the skull.

attack of otitis media many years before. His neurologic examination was entirely normal and he had no signs of raised intracranial pressure. Roentgenograms of the skull in three projections (Fig. 2, *A*, *B* and *C*) showed an accumulation of oil in the hypophysial fossa below the margins of the diaphragm. Also, Robertson[3] mentions the occasional finding of gas in an extension of the subarachnoid space into the pituitary fossa below the diaphragm in normal pneumoencephalograms.

With atrophy of the pituitary gland or after conditions producing prolonged raised intracranial pressure, this space may become quite prominent. In the case of a twenty-nine year old man with a large cystic astrocytoma of the right parietal lobe, the stereoscopic lateral roentgenograms of the skull, in addition to showing large basal cisterns, also clearly showed a large extension of the subarachnoid space into the pituitary fossa (Fig. 3). The brain was found to be under moderately increased pressure at operation. Presumably, long standing raised intracranial pressure produced the enlargement of the intrasellar subarachnoid space.

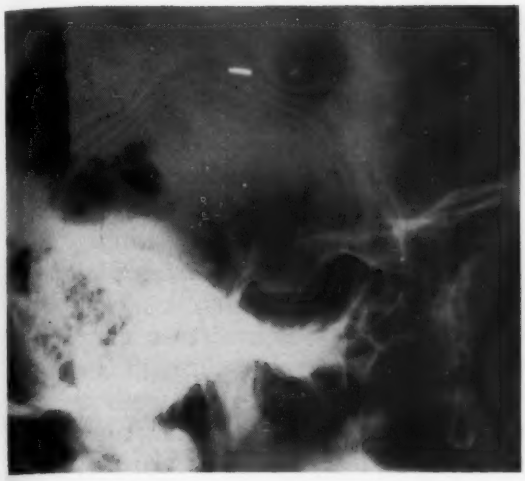

FIG. 3. A large extension of the gas-filled subarachnoid space is demonstrated within the sella turcica.

FIG. 4. A large gas bubble is shown within the sella turcica after radiation therapy of the pituitary adenoma.

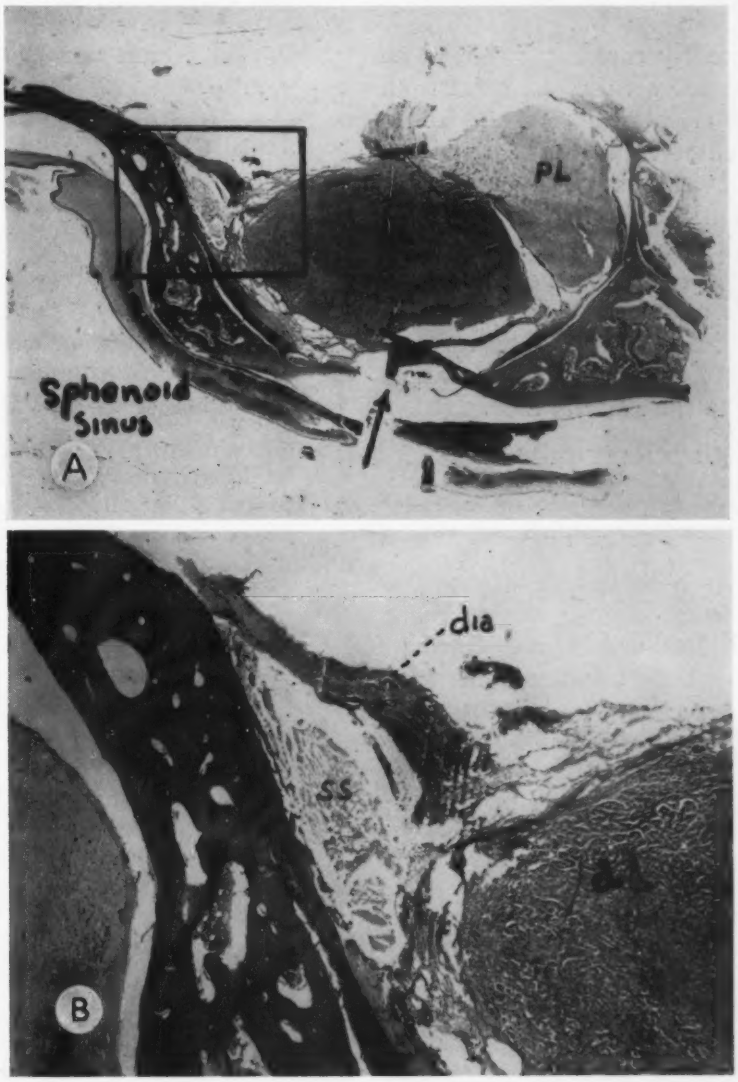

FIG. 5. (*A*) Longitudinal section through the sella turcica. (*B*) Enlarged inset shows a well defined subarachnoid space below the diaphragm anteriorly: ss, subarachnoid space; dia, diaphragm; al, anterior lobe. Pl, posterior lobe. Artifact in floor (arrow) produced by sectioning.

A striking demonstration of this space occurred after cobalt 60 therapy of a chromophobe adenoma of the pituitary gland in a thirty-nine year old man in June, 1956. At that time he received 5,092 gamma roentgens to the pituitary region. Nine months later, a pneumoencephalogram showed a large round gas bubble in the sella turcica on the stereoscopic lateral views (Fig. 4). Postirradiation shrinkage of the tumor was followed by compensatory enlargement of the subarachnoid space into the sella turcica. A similar finding is illustrated by Robertson[3] after radiation therapy of a patient with an eosinophilic adenoma of the pituitary gland.

We have recently carefully removed an intact sella turcica with its contents from the body of a child who died almost instantly of a chest injury. The specimen was decalcified and longitudinal sections (Fig. 5*A*) were made through the region of the infundibulum and diaphragmal foramen. A well-defined space is noted beneath the diaphragm anteriorly (Fig. 5*B*) filled with a pink-staining exudate. This appears to be an extension of the subarachnoid space anterior to the anterior lobe.

SUMMARY

A hypophysial subarachnoid space has been shown on roentgenograms in 3 recent instances. In one case, radiopaque oil accumulated in this space in a normal individual. In another patient, gas outlined the space after postirradiation atrophy of a pituitary tumor. In a third case, demonstration of this space occurred in a patient with raised intracranial pressure due to a brain tumor.

This space was demonstrated in a child in histologic sections through the sella turcica in the area just beneath the diaphragma sellae and anterior to the anterior lobe of the pituitary gland.

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ROENTGENOGRAPHY OF THE BREAST

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IT IS the purpose of this paper to present the rationale for examination of the breast by roentgen means and to discuss briefly some of the criteria for roentgen diagnosis of benign and malignant conditions of the breast.

The foundation for roentgen diagnosis of breast disease has been established through the work of Gershon-Cohen and Ingleby.[1] The anatomicopathologic considerations of breast disease and their roentgenographic correlation have been well presented by these workers in their numerous publications on this subject. Earlier studies in this field are also reviewed by Gershon-Cohen and Ingleby.

TECHNICAL CONSIDERATIONS

Lateral and anteroposterior (cephalocaudad) roentgenograms of each breast are employed routinely. A specially designed cone flattened along one surface and with a semi-elliptic cut-out in its distal portion has been found useful for closer approximation of the cone to usual breast contours (Fig. 1). The lateral roentgenogram is obtained with the patient in the lateral decubitus position, lying on the side to be examined and with the breast extended upon the cassette or disposable film holder (Fig. 2). The cephalocaudad roentgenogram is obtained with the patient in the sitting position. The breast is supported in this position by the cassette or film holder which is in turn held by the patient (Fig. 3). Upper and outer quadrants of the breast are identified on the roentgenogram by appropriate opaque markers.

Regular medical non-screen roentgenographic film is used with a fine focus tube. The target-film distance is 14 inches and factors of 30–32 kv. and 100 ma. are employed. Exposure varies from 0.6 sec. to 4.0 sec. or more, the variable depending more on the density rather than the size of the breast. It has been helpful to place a small lead shot affixed with transparent tape upon the breast over the dominant mass or other area requiring particular study.

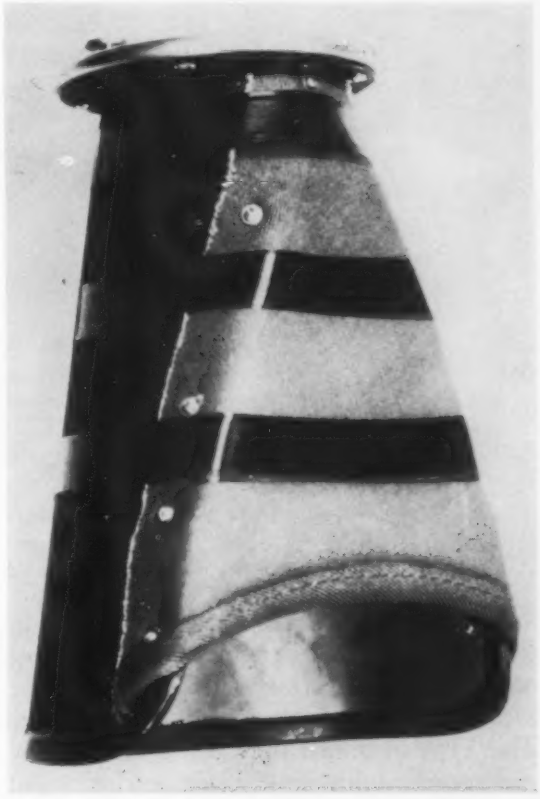

FIG. 1. Roentgenographic cone designed for breast examination. Note the flattened surface for closer approximation of the cone to the chest wall.

INDICATIONS FOR BREAST ROENTGENOGRAPHY

1. Evaluation of the "lumpy" (cystic) breast. The nodular, lumpy or cystic breast constitutes a distinct problem as regards clinical evaluation and management. There are numerous palpable masses or nodules

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Fig. 2. The lateral roentgenogram of the breast is obtained with the patient in the lateral decubitus position, lying on the side to be examined. The breast is extended upon the cassette or disposable film packet.

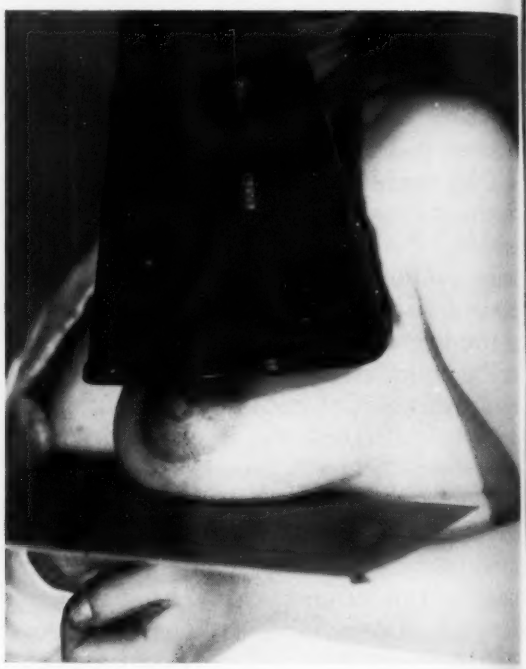

Fig. 3. The anteroposterior (cephalocaudad) roentgenogram of the breast is obtained with the patient seated. The breast is supported by the cassette or film holder which is in turn held by the patient as shown.

within both breasts with no dominant area upon which attention or concern may be focused to the exclusion of other areas. This type of breast may be "screened" by roentgenographic study for exclusion of any unsuspected pathologic change other than the cystic condition itself.[2] The characteristic roentgen appearance of a breast carcinoma is usually quite distinct from the surrounding cystic lesions. Biopsy of any suspicious area is recommended by the roentgenologist.

2. Evaluation of localized breast pain with no palpable mass. Persisting localized pain within one breast with consistent negative physical findings constitutes another difficult problem in clinical management. Roentgen study of the breast, whether normal or abnormal, will frequently afford solution of this problem. Negative roentgen findings, however, with continuing symptomatology warrant the recommendation for repeat examination following a time interval not exceeding one month.

3. Detection of occult breast malignancy in patients without palpable mass but showing other local or distant signs of possible malignant disease. Our experience indicates that roentgenography of the breast should be employed early in the series of survey studies usually contemplated for the female patient exhibiting evidence of metastatic disease without a known primary focus.[3] The incriminating lesion may be identified by means of a simple, relatively inexpensive procedure before resorting to more involved genitourinary or gastrointestinal examination.

4. Roentgen confirmation of clinical impression of breast malignancy prior to surgical intervention. Such confirmatory evidence as may be afforded by roentgenographic examination, even in cases of obvious malignant disease, will reassure the surgeon in his preparations for radical surgery. This supplemental evidence may at times serve an excellent purpose in prepar-

ing the patient and family for acceptance of radical mastectomy.

5. Aid in differentiation between benign and malignant breast disease. This consideration is presented in all instances *in addition* to all of the established indications for biopsy. Quite definite and reliable roentgen criteria have been established for differential diagnosis between adenosis, cysts, fibroadenomas, intraductal papillomas on the one hand and scirrhous, circumscribed or duct carcinomas on the other hand. The roentgen examination is not intended in any instance for replacement of biopsy and subsequent microscopy but rather as an additional supplemental or corollary type of examination. This important qualification must be accepted by the roentgenologist and clearly understood by the referring clinician.

6. Evaluation of the patient with cancerophobia and a positive family history for breast malignancy.

7. Evaluation of therapy (hormonal) in certain benign breast conditions.

8. To study living anatomy and physiology of the breast before, during and after reproductive span.

9. For purpose of studying possible existence of precancerous conditions of the breast.

10. As a survey project among healthy women for early detection of cancer.

ROENTGEN FEATURES OF BREAST DISEASE

Adenosis,[6] which consists essentially of a lobular hyperplasia or an unencapsulated parenchymatous hyperplasia reflects a variant of changes occurring within the breast during different phases of the menstrual cycle (Fig. 4). This occurs in the majority of women during the reproductive years. Adenosis varies in appearance and extent from a small collection of poorly circumscribed rather indistinct fluffy or blurred opacities within the upper portion of both breasts to an extensive almost homogeneous density throughout both breasts which appears to completely obliterate the normal breast architecture. Recognition of

Fig. 4. Adenosis. Note rather indistinct opacities scattered throughout breast with resultant obliteration of normal breast architecture. Identical appearance was presented in opposite breast.

adenosis in its varying forms constitutes one of the major obstacles to be hurdled before any true facility in roentgen diagnosis of breast disease may be obtained. In addition to the problem of recognition of the adenosis itself, there is the very important consideration of the obscuring effect produced by the adenosis upon other, more significant, pathologic changes within the breast. A small carcinoma in its early development may well be overlooked or misinterpreted as a result of surrounding patches of adenosis.

Cysts and fibroadenomas. Many of the roentgen criteria employed for the diagnosis of cysts are equally applicable to fibroadenomas.[4,5] When the two conditions can be differentiated, it is because cyst walls are uniformly smooth and without bosselation of a fibroadenoma (Fig. 5). A clumped

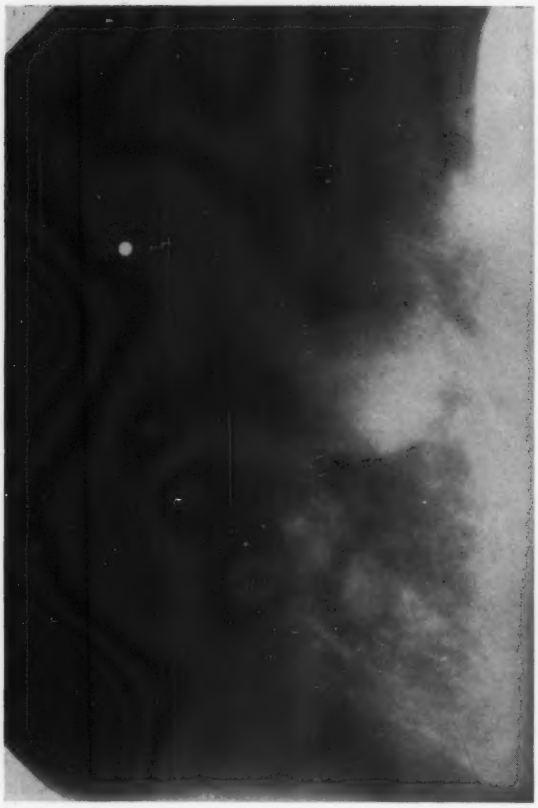

Fig. 5. Cyst. Observe the sharply circumscribed rounded opacity which produces no distortion of surrounding breast structures. Cysts may, of course, vary in size markedly.

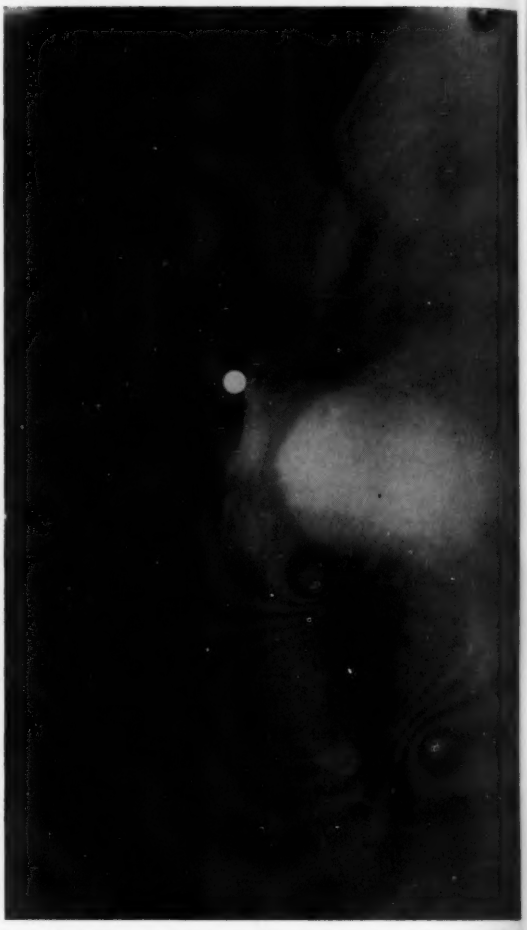

Fig. 6. Fibroadenoma. Sharply circumscribed but somewhat lobulated or bosselated density is clearly demonstrated. Fibroadenomas may be minute in size or may grow to giant size occupying the major portion of a breast.

group of cysts, however, may well simulate the lobulated contour of the fibroadenoma (Fig. 6). Both cysts and fibroadenomas frequently occur in both breasts. Calcification within cysts is rare; it is frequently encountered in fibroadenomas. A fibroadenoma occurs most typically in the adolescent or young adult; cysts appear in women of a slightly more advanced age group. There is at times much difficulty in differentiating on the roentgenogram between a solitary cyst or fibroadenoma and a circumscribed or medullary form of carcinoma. This problem will be treated further under the discussion of circumscribed carcinoma.

Papillomas. Papillomas may be suspected when an elongated tortuous subareolar duct is visualized in relationship to a small nodular density (Fig. 7). Examination in such cases is frequently initiated by the patient's complaint of a nipple discharge of serosanguineous or brownish nature. A palpable nodule may or may not be encountered on clinical examination. It is precisely in those cases with nipple discharge and without palpable abnormality that roentgen examination is invaluable.

Intraductal Hyperplasia. The presence of minute scattered punctate calcifications within the breasts is indicative of an intraductal hyperplasia.* The calcifications may be so small as to escape detection on cur-

* The fine punctate calcifications of intraductal hyperplasia visualized on the roentgenograms do not lend themselves to adequate reproduction and an example of this condition is therefore not included in this series.

sory review of the roentgenograms. A cluster or clump of such tiny calcific deposits in one area introduces strong suspicion that an intraductal carcinoma may be present.

Carcinomas. The most frequently encountered types of malignant growth within the female breast, *i.e.*, scirrhous, circumscribed or medullary and intraductal carcinoma, present different and quite characteristic alterations on the roentgenogram. Differentiation between the different forms of carcinoma is feasible in small early growths as well as in advanced lesions. Carcinomas, as a rule, occur unilaterally within one breast and most commonly correspond with a clinically palpable mass. The

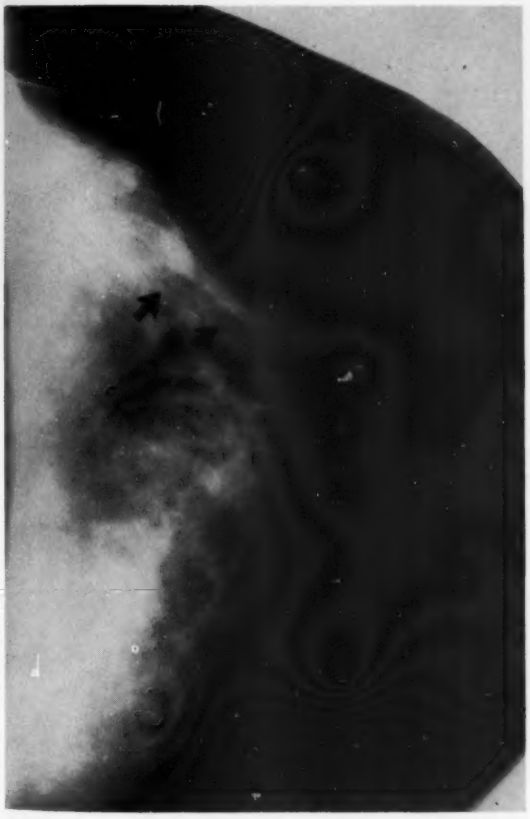

Fig. 7. Intraductal papilloma. In the upper portion of the breast there is seen an irregular elongated density representing a thickened tortuous duct. At the proximal extremity of this duct there is a nodular density suggesting the presence of a papilloma. Intraductal papilloma verified at operation. Patient complained of typical serosanguineous nipple discharge.

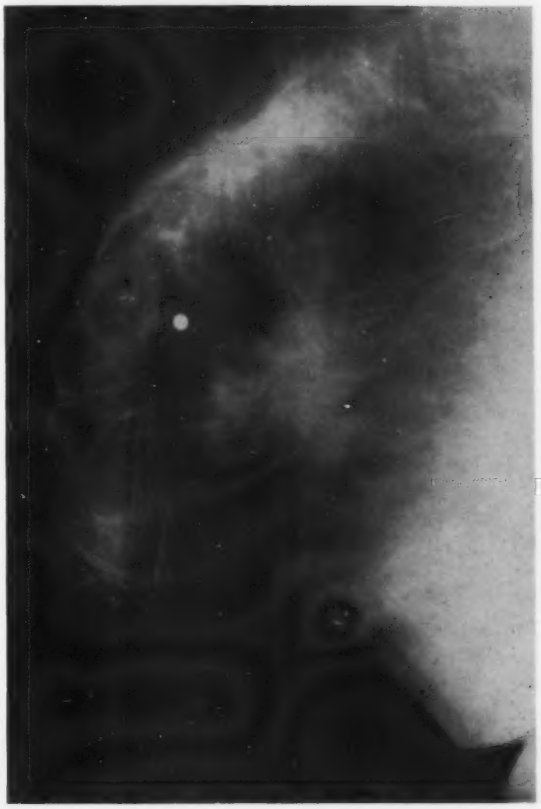

Fig. 8. Scirrhous carcinoma. Irregular spiculated or tentacled density is well shown. The abnormal roentgen shadow is smaller in diameter than the clinically palpable mass.

latter feature is, of course, not present in the case of the small nonpalpable occult lesion which may be fortuitously discovered on roentgen study. Following are some of the roentgen features of carcinomas.

I. Scirrhous Type (Fig. 8). (a) Irregular spiculated shadow of increased density; (b) abnormal shadow on roentgenogram is smaller than the clinically palpable mass; and (c) there occurs a distortion of surrounding breast architecture.

II. Circumscribed or Medullary Type (Fig. 9). (a) Sharply circumscribed rounded density; (b) localized irregular notching or lobulation; and (c) demonstration of a linear localized extension of abnormal density or "tail" into surrounding tissues. Visualization of this tail of increased

FIG. 9. Circumscribed or medullary carcinoma. There is an abnormal rounded density with sharp but slightly irregular margins. Note linear extension or "tail" of increased density extending into adjacent breast tissues. The tail is not invariably present and differentiation from a cyst or fibroadenoma may be difficult or impossible on the roentgenograms.

density constitutes one of the main differential features between a fibroadenoma and a circumscribed carcinoma.

III. Duct Carcinoma (Fig. 10). (a) Punctate calcifications, fine to moderately coarse, usually clumped or grouped irregularly.[7] The calcifications tend to follow the line of the duct; and (b) later in the course of the disease the tumor has the appearance of a scirrhous carcinoma in addition to the above noted calcifications.

DISCUSSION

Roentgenography of the breast has been little used in this country up to the present time. This is explained, at least in part, by the difficulties encountered from a technical standpoint in obtaining roentgenograms of high diagnostic quality. More important, however, is the difficulty in roentgen interpretation. Considerable time and applica-

FIG. 10. Duct carcinoma. A clumped group of fine punctate calcifications is seen within the breast in a subareolar location. The calcifications tend to follow the course of the ducts extending deeper into the breast. A mass was palpable deep to the areola. Pathologic report: Intraductal carcinoma.

tion must be expended by the radiologist before sufficient facility is developed to warrant a reasonable confidence in his ability to properly interpret and diagnose breast pathology. The period of indoctrination requires adherence to a program of clinical evaluation of each patient by the physician who is to interpret the roentgenograms as well as close pathologic correlation in each case which has undergone surgical intervention. The discipline required to achieve a competence in breast roentgenography is no different or no greater than that required in many other areas of diagnostic roentgenography.

The question has been asked, "Why should we burden ourselves with the problems of roentgenographic examination of the female breast when proper management of the patient in most cases will lead to biopsy anyway?" This question may be answered by repeating the dictum that there are no short cuts in medicine. Any diagnostic information which may be obtained by additional study without detriment to the patient should be sought without stint or reservation. There is no thought of omitting roentgen study of the chest in an individual with hemoptysis and a positive sputum. There similarly should be no hesitation to obtain whatever additional information may be made available by a roentgen breast examination despite the clarity of the clinical picture. Completely unsuspected pathology may be uncovered in either the breast under observation or, as has occurred in many instances in our experience, in the contralateral breast. One of the great values of the roentgen examination has been the opportunity it has afforded in detecting a disease process *before* it is clinically manifest.

There seems little doubt that the practice of breast roentgenography will lead to an increased number of breast biopsy examinations rather than a decreased number of cases eventuating in such surgical exploration. It is hoped that the result of this more intensive type of investigation will lead to detection of breast cancer in earlier phases of growth with resultant improvement in survival statistics.

It is recognized that the procedure under discussion should remain on a quasi-investigative basis until a more general acceptance for this type of roentgen examination is obtained. Final evaluation, it is hoped, will come from the general body of radiologists and not from the limited number of early investigators. To achieve this proper evaluation, a more widespread adoption of roentgen breast examinations is urged.

RESULTS

A review of the diagnostic accuracy achieved in 1,000 consecutive breast examinations performed from July 8, 1955 to April 11, 1957 is presented in Table 1. It may be noted that 372 of the 1,000 cases studied roentgenographically were subjected to biopsy examination.

An analysis of the accuracy of roentgen examination in relation to microscopic findings following surgical intervention is best served by a consideration of groups of cases classified according to the preoperative roentgen diagnosis. No discrepancy in diagnosis was encountered in 10 individuals who were operated upon following negative findings on roentgenographic examination.

Of 144 women who were studied by biopsy following a diagnosis of a benign breast condition (adenosis, cyst, fibroadenoma, papilloma, intraductal hyperplasia) pathologic verification of the roentgen findings was obtained in 141 instances. A malignant process not detected on roentgen examination was discovered by the pathologist in 3 individuals. The diagnostic accuracy in this group of cases was 97.9 per cent.

A second group of 65 women with a roentgen diagnosis of a benign condition was subjected to surgery and biopsy examination. In this group biopsy was recommended by the radiologist despite the impression of a benign process because of various circumstances such as very dense compact breast structure, localization of a lesion in the axillary tail of the breast, un-

TABLE I

DIAGNOSTIC RESULTS IN 1,000 CONSECUTIVE BREAST EXAMINATIONS FROM JULY 8, 1955 TO APRIL 11, 1957

Roentgen Interpretation	No. of Cases	No. of Cases Operated On	Operative Findings		Per Cent Accuracy
			Normal or Benign	Malignant	
Normal	99	10	10	0	100
Benign	585	144	141	3	97.9
Benign lesions, but various circumstances indicating need for biopsy*	133	65	60	5	92.3
Malignancy suspected	93	71	36†	35	49.3
Definite malignancy	90	82	1	81	98.8
Totals	1,000	372	248	124	

* Very dense breast, lesion in axillary tail of breast, incompletely visualized lesion or technically poor examination.
† Includes severe intraductal hyperplasia.

satisfactory technical examination, etc. It was not felt in this group of cases that an unequivocal roentgen interpretation was possible and biopsy examination was deemed essential. Of this group, 5 instances of breast malignancy were discovered by the pathologist, yielding a 92.3 per cent accuracy.

In a group of 82 women in whom a definite roentgen diagnosis of carcinoma was established, pathologic verification was obtained in 81. One patient was found to have a benign process on microscopic study. A 98.8 per cent corroboration of roentgen findings was obtained in this group. It should be stressed at this point that the results here delineated were encountered in consecutive examinations. Of the 82 women presenting roentgen evidence of malignancy, a number were clinically obvious. Similarly, a fair proportion of these cases were clinically indeterminate and in a few there was no suspicion of malignancy from a clinical standpoint.

The above category of diagnosis, *i.e.*, "definite malignancy" is differentiated from the group in which a roentgen diagnosis of "suspected malignancy" was submitted. In this latter group of cases were included many women in a relatively younger age group, *i.e.*, in the third and fourth decades with actively secreting glandular breast components. It is in this type of relatively dense breast that difficulty in establishing a clear cut diagnosis may be encountered. It is in this type of breast that roentgen diagnosis between benign and malignant processes may be difficult and, similarly, it is in this type of breast that clinical evaluation is most confusing. Also included with these suspected malignancies were the cases of severe intraductal hyperplasia. Any breast roentgenogram exhibiting a cluster of fine calcifications with or without scattered fine calcifications warranted suspicion of intraductal neoplasia and biopsy was considered mandatory in all such instances.

Biopsy was urged for any shadow or shadow complex which did not unequivocally fall into the group of benign lesions. Of the 71 individuals included in this category, in approximately 50 per cent (49.3 per cent) confirmation of the roentgenographic opinion of malignancy was obtained on histologic study. The remaining cases proved benign, or, in a small number of instances, entirely normal. It is hoped

that further investigation and experience with this borderline group will permit an improved diagnostic accuracy.

SUMMARY

An attempt has been made to present the rationale for roentgenographic breast examination. It has been determined in our experience that a definite contribution to diagnosis and management of breast disease and to earlier detection of breast cancer is made available by the utilization of this diagnostic method. Close clinical and pathologic correlation is necessary for proper application of roentgen diagnosis in study of diseases of the breast. It is not intended that biopsy be supplanted by roentgen examination. Increased use of breast roentgenography may well lead to an increased number of biopsy examinations as a result of detection of previously unsuspected abnormalities. Roentgen criteria for diagnosis of benign breast conditions are outlined and the roentgen features of the different types of breast cancer are discussed.

Breast roentgenography is now employed by a number of isolated groups of radiologists. More wide-spread adoption of this method is urged so that final evaluation will be based on the largest possible experience.

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THE ROENTGEN SENSITIVITY OF VARIOUS PORTIONS OF THE EYE OF YOUNG AXOLOTL (SIREDON MEXICANUM)*

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INTRODUCTION

THE material for this paper was accumulated over a period of three years, and 80 animals were investigated histologically. Therefore, the material was large enough for definite conclusions. This gave us the possibility of extending and modifying our early conclusions concerning the roentgen sensitivity of various portions of the eye of these animals.[5,6]

MATERIALS AND METHODS

The heads of 90 young axolotls (Siredon mexicanum) twenty-five or thirty-two days after hatching were irradiated locally with 3,000 r and the heads of 15 animals forty-nine days after hatching were irradiated with 6,000 r. In addition, 10 animals were irradiated with 4,000 r and 5 animals with 5,000 r. Forty-three animals served as untreated controls. The irradiations were made during two successive years (1954 and 1955). The conditions of irradiations were almost the same. In 1954, the factors were as follows: 100 kv., with no external filtration; 5 ma.; 200 r/min.; target object distance, 18 cm. In 1955: 100 kv., added filter 5 mm. Al, beryllium window tube, half value layer 1.25 mm. Al; 30 ma.; 1390 r/min.; target object distance, 18 cm. The very slight differences should have no effect on the results.

The animals were anesthetized before irradiation by placing them in an aqueous solution of M.S. 222 (tricaine methanesulfonate). During irradiation the animals were arranged in radial position within a circle on moistened filter paper. The posterior portions of the animals were covered with moist cotton. The nonirradiated portions were shielded with a lead covering (made from a 4 mm. lead sheet) with a round radiation localizer about 10 cm. in diameter[4]. After the treatment the animals were placed in fresh water where they recovered rapidly.

The irradiated and control animals were sacrificed and fixed over a period of three years. Fixations were made using a saturated solution of bichloride of mercury with 5 per cent acetic acid and in acetic mercuric chloride formalin (Stieve). Sixty irradiated animals and 10 controls were examined histologically and in addition 10 animals from our experiments published earlier[5] were reinvestigated. Therefore, the total number of animals studied amounted to 70 experimental and 10 controls.

The material was embedded in paraffin plus 5 per cent beeswax, and sectioned at 8 or 10μ. The sections were stained with Ehrlich's hematoxylin and eosin. Photomicrographs were made at different magnifications ($\times$ 37, $\times$ 160, $\times$ 450 and $\times$ 510).

RESULTS

In our previous papers concerning this subject,[5,6] we limited our investigation almost exclusively to the study of the influence of irradiation on the development of retina and choroid. The great sensitivity of the rods and cones layer of the retina and the great resistance of pigment cells of the choroid to irradiation was established. In the present paper, the comparative sensitivity of cornea, lens and retina is considered.

A. *Cornea.* The normal cornea of axolotl consists of substantia propria (translucent dense connective tissue) and epithelium of cornea (Fig. 1*A*). The stratified squamous epithelium of cornea is very thin as compared to the thickness of normal skin near the eye (Fig. 1, *A* and *C*.) The number

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of cell layers is less than in normal skin and the cells are much smaller in size. The pigment cells that can be found in some regions of normal skin epithelium (Fig. 1*C*) are absent in the epithelium of cornea. Especially typical is the complete absence of Leydig's cells in normal corneal epithelium. Leydig's cells developed in some regions of normal skin epithelium in very large numbers (Fig. 2*A*).

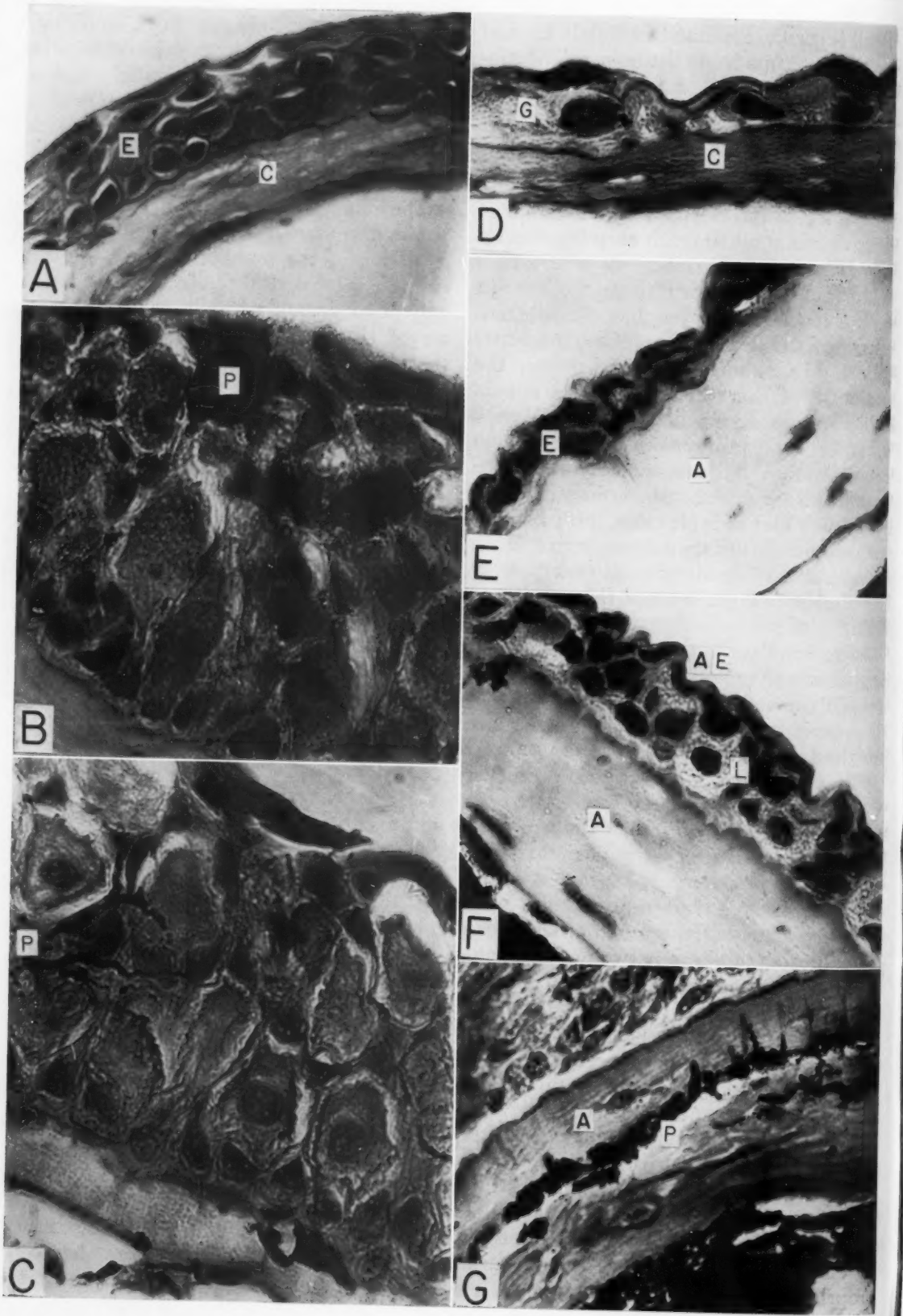
Normally, the corneal epithelium in axolotl is a little thicker than the substantia propria (Fig. 1*A*). Therefore, it is clear that a big difference exists between the structure of the cornea in axolotl and in man. In the latter, according to Ham,[12] the substantia propria comprises about 90 per cent of the thickness of the cornea. The fine structure of substantia propria, however, is similar in both cases. This layer of cornea contains flattened connective tissue cells that are distributed between parallel bundles of collagenic fibers (Fig. 1, *E* and *F* and 2*B*).

After irradiation, the cornea never disappeared completely. In 38 per cent of all cases it was damaged. In some cases the substantia propria was almost normal in appearance and had normal thickness (Fig. 1, *A* and *D*). In other cases, it was two times thicker than normal (Fig. 4*A*) and sometimes even three or four times thicker (Fig. 1, *E* and *F*). A substantia propria thinner than normal was never observed. It was clear that in some cases the substantia propria lost its transparency after irradiation. This can be the result of abnormal thickness or the result of development of pigment cells in this layer. Figure 1*G* shows the cornea of the animal fixed two hundred and thirteen days after irradiation with accumulation of pigment cells in the substantia propria. It is noteworthy that Rohrschneider[24] observed the same phenomenon in irradiated cornea of rabbit. Figure 2*A* shows the section through the head of animal (VI. 114) fixed four hundred and nineteen days after irradiation. Only rudiments of the eye could be observed in this case. The substantia propria also changed considerably in this case. It was abnormally thick and had many pigment cells and thin blood vessels. The normal disposition of parallel bundles of collagenic fibers in this case was disturbed. The undulating configuration with disturbance of parallel disposition was typical for this damage.

The damage of corneal epithelium was different in various cases. In some cases the reduction of the number of layers of this epithelium was typical. In extreme cases only two layers of cells could be observed (Fig. 1, *D* and *E*). Simultaneously, the development of giant cells in this epithelium could be seen (Fig. 1*D*). In other cases, the epithelium was a little thicker than normal and development of separate Leydig's cells was typical (Fig. 1*F*). This never occurred in control animals. Figure 4*A* shows the section through the eye of animal (V. 82) fixed forty-eight days after irradiation. In this case the epithelium of the cornea was three times thicker than normal. The number of cell layers in this epithelium was much larger than normal. Between the cells of epithelium, Leydig's cells were present and in some places, giant cells.

The most serious corneal damage was observed in 29.5 per cent of all cases. In all these animals the epithelium of the cornea disappeared completely and was replaced by typical skin epithelium with large numbers of Leydig's cells. The substantia propria usually was only damaged as described above. The appearance of such skin epithelium which replaced the corneal epithelium was identical to the appearance of typical skin epithelium near the eye of control animals (Fig. 1, *B* and *C*). Figure 2 shows two examples of complete replacement of corneal epithelium by typical skin epithelium with large numbers of Leydig's cells. One animal was fixed one hundred and forty days and others, four hundred and nineteen days after irradiation. In 32.5 per cent of all animals, the cornea was normal.

B. *The Lens.* The normal lens of control animals (Fig. 3*A*) had an almost homogeneous structure with slight concentric layers.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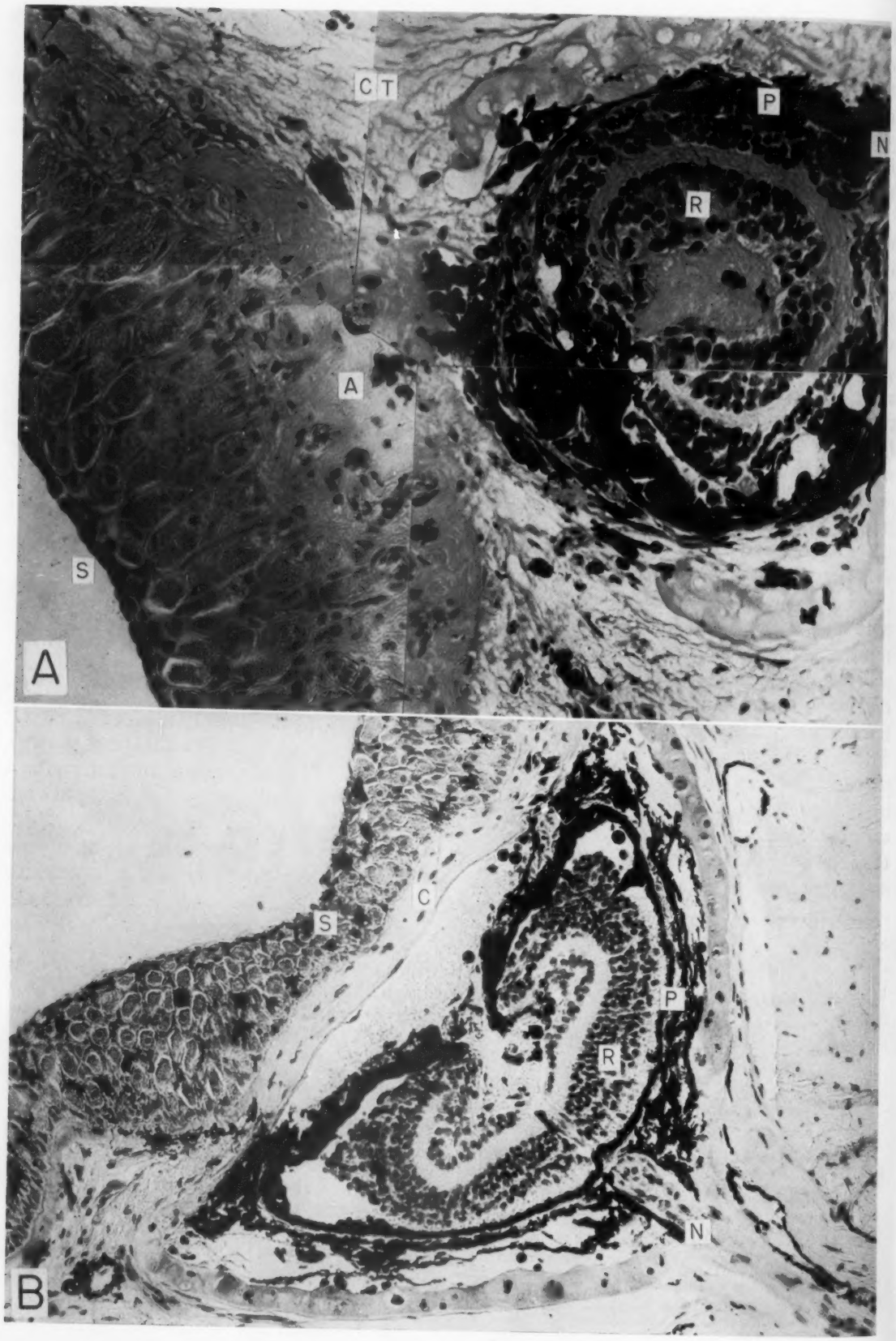
The lens was covered with a homogeneous capsule, a cuticular membrane. Beneath it the epithelium of the lens was located (Fig. 3*A*). These structures were similar with such structures of human lens.[19] Cells, vacuoles or granules inside of the normal lens were never observed. Cracks of the lens were typical. The formation of these cracks obviously is an artefact, but at the same time is a response of a definite type of lens structure to fixation. They are mostly found in a definite direction—parallel to the direction of lens fibers. These cracks were observed consistently in the lens of nonirradiated animals (Fig. 3*A*), but they disappeared almost completely even after slight roentgen damage (Fig. 3*B*). In some cases cracks appeared only in the central portion of the irradiated lens, when the peripheral portion was entirely changed (Fig. 3, *C* and *D*). The normal lens could be observed in 16.8 per cent of irradiated animals; in 55.5 per cent varying lens damage could be noted. It was possible to distinguish three types of damage: slight, moderate and serious. Slight damage was observed in 4.6 per cent of all cases. In slight damage, formation of granules, vacuoles and spheres of different size and number was typical. Figure 3*B* is an illustration of very slight damage of the lens in an animal twenty-seven days after irradiation. In this case the lens membrane and epithelium of the lens could be noted. Also, a few typical cracks could be observed. But, at the same time, changes in lens structure were obvious. Only in some places could typical concentric layers of lens material be found (Fig. 3*B*, CL). The many large or small vacuoles and spheres developed chiefly in the peripheral portion and, therefore, these layers were not distinguishable. Figure 4*B* shows another example of slight damage, but more serious than in the first case. In this animal, fixed twenty-six days after irradiation, the entire lens contained a great number of vacuoles of different sizes. In addition, the lens membrane ruptured causing formation of an extra lens lobule. It is clear that in some cases destruction progresses gradually from the periphery to the center while in other cases it quickly affects the entire lens.

Moderate damage was noted in 22.1 per cent of all animals. This damage was characterized by very great disturbances in all peripheral portions. More than one half of the lens was completely transformed into a globular mass with granules, spheres and vacuoles of various size. Only the central portion of the lens retained its original structure with typical cracks (Fig. 3, *C* and *D*). Figure 4*A* shows that the central portion of the lens (central nucleus) is almost normal and the peripheral portion seriously damaged. It is obvious that in destruction of the peripheral portion of the lens, fibers were partially dissolved so that

FIG. 1. *Cornea.* (*A*) Part of the frontal section through the cornea of control animal (N.4) fixed 100 days after hatching. Photomicrograph ×510. (*B*) Part of the sagittal section through the head of animal (II.23) fixed 140 days after irradiation with 3,000 r and 170 days after hatching. Complete absence of corneal epithelium, which was replaced by typical skin epithelium. Photomicrograph ×510. (*C*) Part of the frontal section through the head of control animal (N.4) fixed 100 days after hatching. Typical skin epithelium near the eye. Photomicrograph ×510. (*D*) Part of the section through the cornea of animal (V.81) fixed 27 days after irradiation with 3,000 r and 53 days after hatching. Modification of corneal epithelium. Photomicrograph ×510. (*E*) Part of the section through the cornea of animal (V.89) fixed 174 days after irradiation with 3,000 r and 204 days after hatching. Modifications of corneal epithelium and substantia propria. Photomicrograph ×510. (*F*) Part of the section through the cornea of animal (V.88) fixed 173 days after irradiation with 3,000 r and 203 days after hatching. Modification of corneal epithelium and substantia propria. Photomicrograph ×510. (*G*) Part of the section through the substantia propria of animal (II.25) fixed 213 days after irradiation and 245 days after hatching. Photomicrograph ×510. A—abnormal substantia propria; AE—abnormal epithelium of the cornea; C—substantia propria normal in appearance; E—epithelium of the cornea; G—giant cells of corneal epithelium; L—Leydig's cell; P—pigment cells.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many empty spaces can be noted in this area (Fig. 3*D* and Fig. 4*A*). The many large folds of the lens membrane result from the reduction of the peripheral portion (Fig. 3*D*). In all these cases the destruction of the lens occurred gradually from the periphery to the center.

Serious damage occurred in 28.8 per cent of all irradiated animals. This damage was characterized by almost complete disappearance of the normal substance of the lens. The dissolving of the lens fibers, which was described above, progressed gradually in cases of serious damage. As a result only the remnants of the lens could be noted in most cases. The most resistant structure is the lens membrane which forms many small folds especially typical for this stage of damage (Fig. 5, *A* and *B*). It was noted in many cases that after complete disappearance of the lens a small body was discovered consisting only of wrinkled lens membrane. For a long time the cause of the dissolution of the lens substance after irradiation was not clear to us. It was emphasized that in the normal lens cells are never observed. Therefore, we were suprised to find a great number of large cells in the body of the seriously damaged lens. Figure 5*A* shows only a few such cells in the peripheral portion of the lens, but, occasionally, a very large number of such cells was discovered in a seriously damaged lens (Fig. 5*B*). In both of these photomicrographs it is possible to see the wrinkled lens membrane and many large or giant cells inside the lens. It is noteworthy that in the last case these cells take up about one-half of the space of the lens. If we take into consideration our previous observations concerning the activity of giant cells in irradiated tissues,[2,3,8] it is clear that these cells are migrating giant cells—macrophages, which are phagocytes destroying the substance of the irradiated lens. Obviously, they partially phagocytized and partially dissolved the lens fibers, because for their activity the phagocytosis and lysis are both typical.

It is clear that the lens can disappear completely after irradiation. Actually, in 27.7 per cent of all irradiated animals the lens was absent. Figure 2, *A* and *B* shows two examples of rudiments of the eye without the lens. The question arose as to why the lens, which is so sensitive to roentgen irradiation, was normal in appearance in more than 16 per cent of the cases. Tables I and II give the answer to this question. In these tables we see two groups of experimental animals. In all animals of one group the lens was normal in appearance; in all animals of the other group the lens was absent. In these tables it is possible to see that the mean age of animals at the time of irradiation and mean dose were approximately the same. Only one clear difference exists. The mean number of days between irradiation and fixation was about twenty-eight for the group with lenses normal in appearance and one hundred and sixty-five for the group with absent lenses. We therefore concluded that in the first group, sacrificed during the latent period, the animals were fixed too early to show any changes in the irradiated lens; thus the lens was normal in appearance. If we eliminated this group of animals, damage was observed in 100 per cent of all irradiated animals. The eyes are very sensitive to irradiation, but

FIG. 2. *Cornea and Rudiments of the Eye.* (*A*) Part of the section through the head of animal (VI.114) fixed 419 days after irradiation with 3,000 r and 445 days after hatching. Relation between the skin epithelium, which replaced the epithelium of the cornea and rudiment of the eye. Photomicrograph ×160. (*B*) Part of the section through the head of animal (II.23) fixed 140 days after irradiation with 3,000 r and 170 days after hatching. Rudiments of the eye. Photomicrograph ×100. A—abnormal substantia propria of the cornea; C—substantia propria; CT—connective tissue; N—optic nerve; P—pigment cells of choroid; R—retina; S—typical skin epithelium with Leydig's cells, which replaced the corneal epithelium.

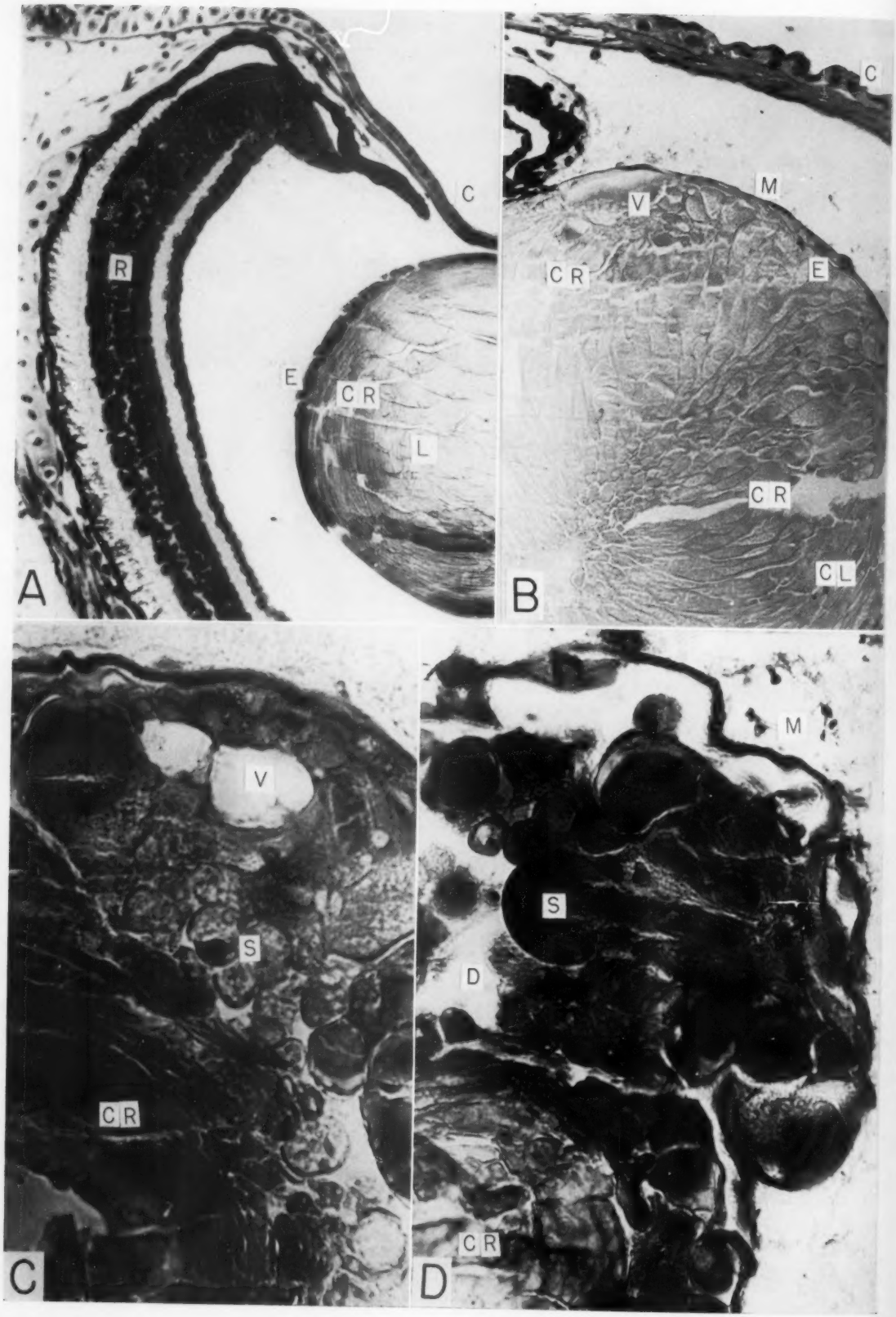
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TABLE I

THE COMPARISON OF AGE, TIME OF FIXATION, DOSES AND REACTIONS TO IRRADIATION OF DIFFERENT PORTIONS OF THE EYE OF 10 EXPERIMENTAL ANIMALS

No.	Age of Animal (in days) at Time of Treatment	No. of Days between Irradiation and Fixation	Dose (r)	The Reactions to Irradiation of:			
				Lens	Cornea (epithelial portion)	Retina	
						Rods and Cones Layer	Other Layers
II	65	29	5,000	normal in appearance	normal in appearance	serious damage	normal in appearance
II-7	16	27	4,000	normal in appearance	damage	serious damage	normal in appearance
II-99	49	29	6,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
II-13	32	38	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
II-12	32	30	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
X-191	26	5	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
II-22	26	22	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
IV-61-A	26	19	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
X-183	26	50	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
X-181	26	27	3,000	normal in appearance	normal in appearance	normal in appearance	normal in appearance
	32.4	27.6	3,600	100% normal in appearance	90% normal in appearance 10% damage	80% normal in appearance 20% serious damage	100% normal in appearance

react comparatively slowly.[7] Therefore, damage of the lens was clear, if fixation was made late enough.

C. *The Retina.* In the retina it is necessary to distinguish between damage of the rods and cones layer and damage of the other layers. According to our previous observations, the rods and cones layer of the retina is the most sensitive. The sensitivity of this layer is almost the same as the sensitivity of the epithelium of the cornea.

In 30.6 per cent of all cases this layer was completely absent. In 33.1 per cent it was damaged. It was possible to distinguish serious damage (9 per cent) when only remnants of this layer were preserved, moderate damage (15.1 per cent) when about one-half of the layer was badly damaged, and partial damage (9 per cent) when only some portions of this layer were partially damaged. Finally, in 36.3 per cent of all animals this layer was normal in appearance. Figures 2*A*, 4*C* and 6*B* give examples of retinas with complete absence of the rods and cones layer. Figure 6*A* shows only remnants of this layer and Figure 4*A* shows an example of the retina with the layer only partially damaged.

Other layers of the retina are much more resistant to irradiation than the rods and cones layer. The complete absence of retina was not observed and in only 5.7 per cent was the damage of all layers of retina so serious that only small rudiments of retina (remnants) were noted. In 4.3 per cent about one-half of the retina layers was destroyed and in 5.7 per cent damage was observed only in some portions of the retina layers. In most cases (84.3 per cent) the appearance of the retina layers was

FIG. 3. *Lens.* (*A*) Part of the section through the eye of control animal (N.1) fixed 25 days after hatching Photomicrograph ×160. (*B*) Part of the section through the eye of animal (V.81) fixed 26 days after irradiation with 3,000 r and 53 days after hatching. Early changes in the lens. Photomicrograph ×160. (*C*) Part of the section through the lens of animal (II.101) fixed 41 days after irradiation with 6,000 r and 90 days after hatching. Degeneration of peripheral portion of the lens. Photomicrograph ×510. (*D*) Part of the section through the lens of animal (V.82) fixed 48 days after irradiation with 3,000 r and 78 days after hatching. Degeneration of peripheral portion of the lens. Photomicrograph ×510. C—cornea; CL—concentric layers of the lens; CR—cracks in the lens; D—dissolved portion of the lens; E—epithelium of the lens; L—lens; M—lens membrane; R—retina; S—spheres in the lens; V—vacuoles in the lens.

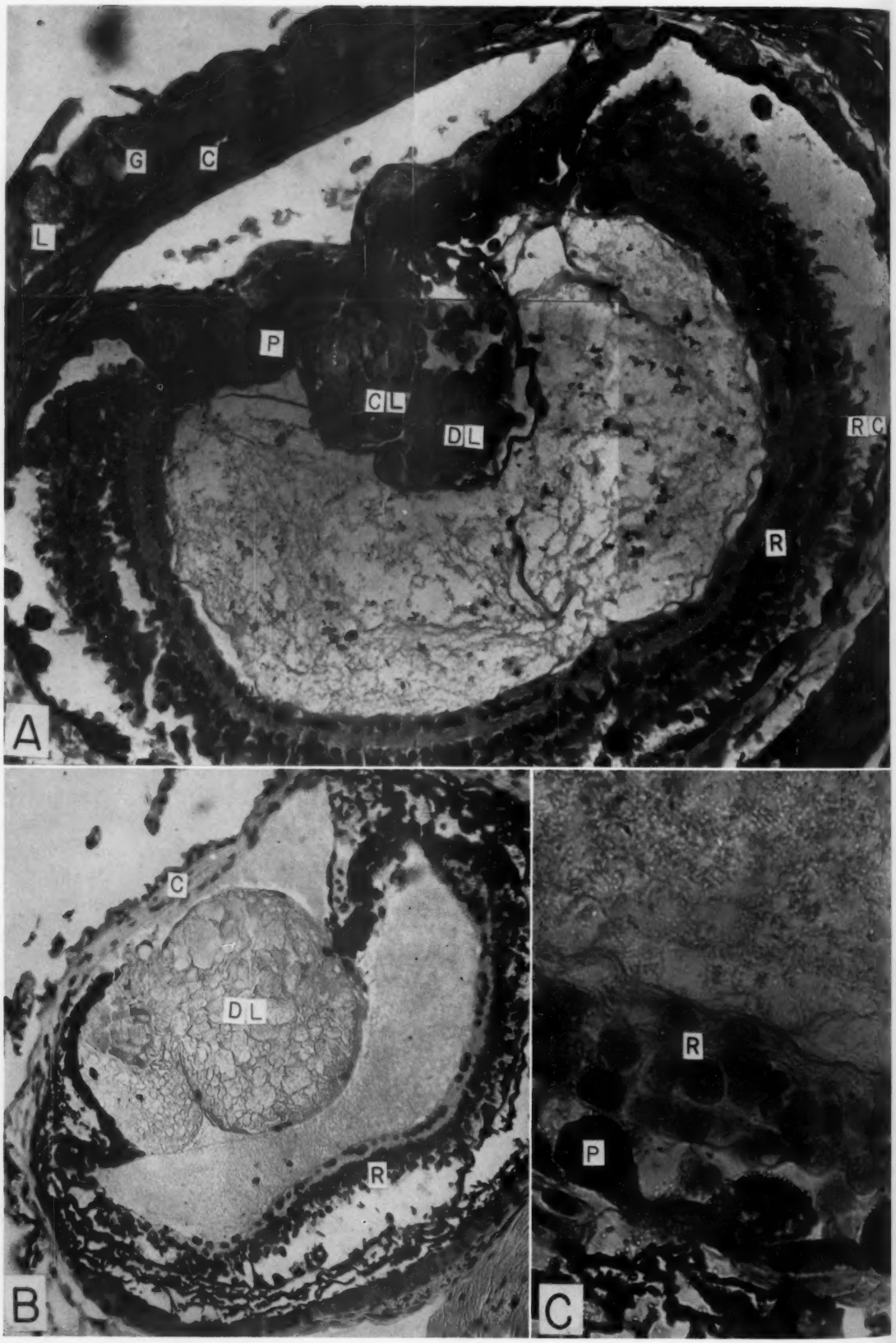
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TABLE II

THE COMPARISON OF AGE, TIME OF FIXATION, DOSES AND REACTIONS TO IRRADIATION OF DIFFERENT PORTIONS OF THE EYE OF 16 EXPERIMENTAL ANIMALS

No.	Age of Animal (in days) at Time of Treatment	No. of Days between Irradiation and Fxation	Dose (r)	The Reactions to Irradiation of:			
				Lens	Cornea (epithelial portion)	Retina	
						Rods and Cones Layer	Other Layers
7-I	16	69	4,000	absent	absent	absent	damage
7-III	16	52	4,000	absent	absent	damage	normal
I	53	117	4,000	absent	damage	absent	remnant
II-25	32	213	3,000	absent	absent	absent	damage
II-105	49	154	6,000	absent	absent	absent	remnant
II-111	49	149	6,000	absent	absent	absent	normal
II-20	32	141	3,000	absent	absent	damage	normal
II-30	32	158	3,000	absent	damage	damage	normal
IV-69	26	107	3,000	absent	absent	absent	normal
V-87	26	119	3,000	absent	damage	damage	normal
VI-104	26	83	3,000	absent	absent	absent	normal
VI-106	26	111	3,000	absent	absent	absent	normal
VI-108	26	174	3,000	absent	absent	damage	normal
VI-111	26	288	3,000	absent	absent	absent	normal
VI-112	26	288	3,000	absent	damage	absent	normal
VI-114	26	419	3,000	absent	absent	absent	normal
	30	165	3,560	100% absent	75% absent 25% damage	62.5% absent 37.5% damage	12.5% remnants 12.5% damage 75% normal

completely normal. Normally, the nuclear portion of retina has 7 to 8 layers of cells. We can see normal nuclear layers of retina in Figure 4*A* in an animal fixed forty-eight days after irradiation with 3,000 r. In irradiated animals the number and typical distribution of nuclear layers can be disturbed. In Figure 4*C* only 3 or 4 layers of cells in an animal fixed thirty-seven days after irradiation with 6,000 r are seen. Another similar example is shown in Figure 6*A*. In some cases abnormal differentiation of retinal cells could be observed. In such cases some cells of nuclear layers were abnormally large (giant cells) and other cells were abnormally small and darkly stained (picnotic cells) as was seen in the retina of animals fixed twenty-eight days after irradiation with 6,000 r (Fig. 5*D*) or two hundred and forty-seven days after irradiation with 3,000 r (Fig. 6*B*).

In the rudiments of the eye, the retina was sometimes differentiated into some abnormal layers (Fig. 2, *A* and *B*) and in

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FIG. 4. *Cornea, Lens and Retina.* (*A*) Part of the section through the head of animal (V.82) fixed 48 days after irradiation with 3,000 r and 73 days after hatching. Damage of various portions of the eye. Photomicrograph ×160. (*B*) Part of the section through the head of animal (II.63) 26 days after irradiation with 6,000 r and 58 days after hatching. Damage of the lens. Photomicrograph ×100. (*C*) Part of the section through the eye of animal (II.101) 37 days after irradiation with 6,000 r and 69 days after hatching. Damage of retina. Photomicrograph ×510. C—substantia propria of the cornea; CL—central portion of the lens almost normal in appearance; DL—damaged peripheral portion of the lens; G—giant cells in corneal epithelium; L—Leydig's cell in corneal epithelium; P—pigment cells; R—retina; RC—rods and cones layer of the retina.

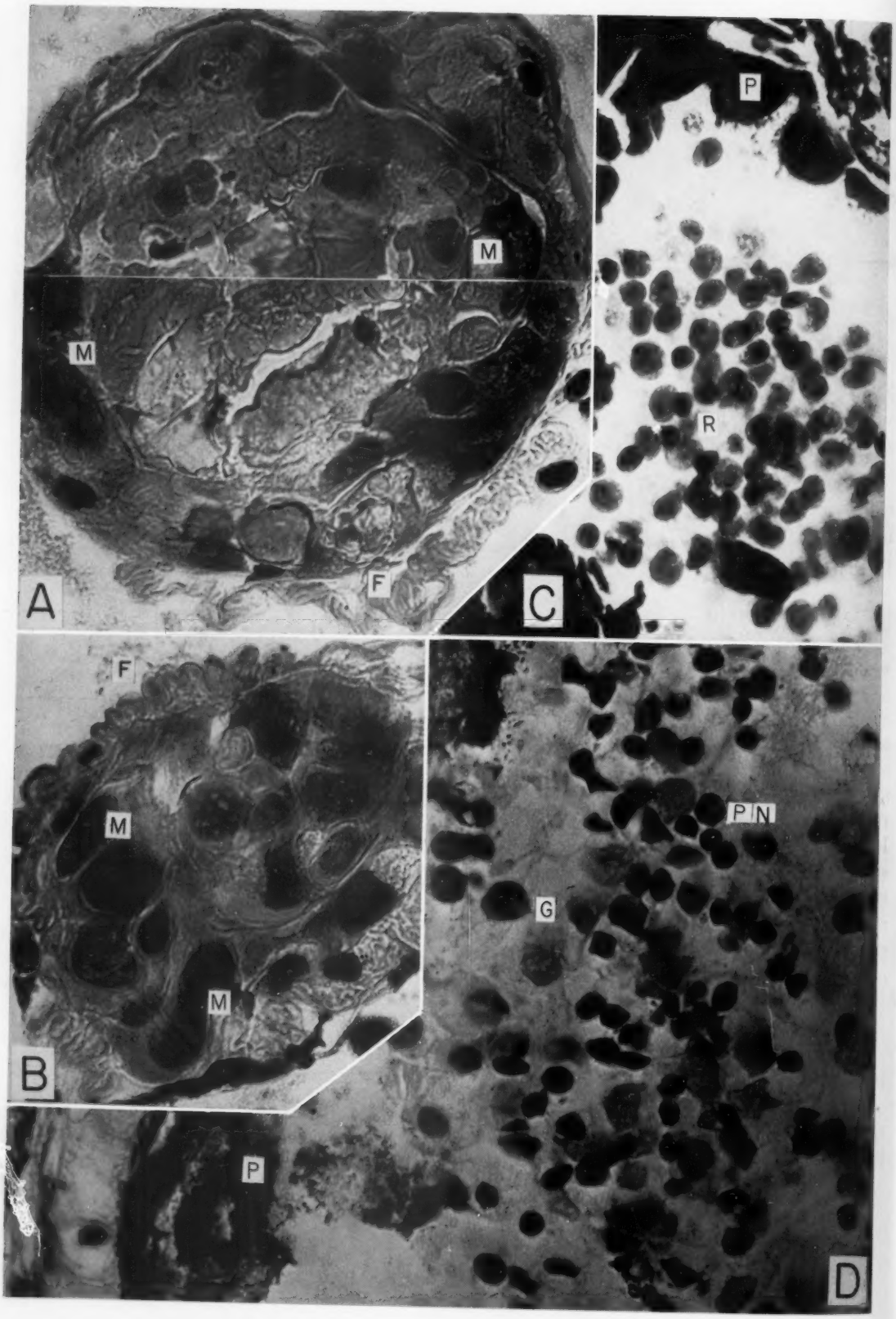
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TABLE III

THE EFFECTS OF IRRADIATION ON DIFFERENT PORTIONS OF THE EYE

Lens			Cornea		Retina					
					Rods and Cones Layer			Other Layers		
Absent	27.7%		Absent (epithelial portion)	29.5%	Absent	30.6%		—		
Serious damage	28.8%		Damage	38.0%	Serious damage	9 %		Remnants only	5.7%	
Moderate damage	22.1%	55.5%			Moderate damage	15.1%	33.1%	Serious damage	4.3%	15.7%
Slight damage	4.6%				Partial damage	9 %		Moderate damage	5.7%	
Normal	16.8%		Normal	32.5%	Normal	36.3%		Normal		84.3%

other cases the retina was only an accumulation of undifferentiated cells (Fig. 6*C* and Fig. 5*C*).

Damage of one portion of the eye usually corresponded to damage of other portions. There were exceptions. Tables I and II give some illustrations of this fact. In a group of animals with the lens normal in appearance in 100 per cent of the cases, the cornea was normal in 90 per cent, the rods and cones layers in only 80 per cent (20 per cent were seriously damaged) and other layers of the retina were normal in 100 per cent. In another group of animals (Table II) with the lens destroyed in 100 per cent of the cases, the cornea was absent in 75 per cent, the rods and cones layers in only 62.5 per cent and other layers of the retina were normal in 75 per cent.

DISCUSSION

Table III shows the comparative radiosensitivity of different portions of the eye.

Our previous conclusion that the rods and cones layer in axolotl is the most sensitive portion of the retina is correct, but our statement that the retina in these animals is the most sensitive portion of the eye to irradiation is not correct. Other portions of the eye were not investigated enough. It is clear now as a result of study of much larger material, that the lens is the most radiosensitive portion of the eye.

It is necessary to note that in the literature we have contradictory data concerning sensitivity of the rods and cones layer to roentgen irradiation. Our investigations showed the great sensitivity of this layer in axolotl. Lorenz and Dunn[17] reached the same conclusion after investigation of newborn mice. Also, according to Noell and co-workers,[20] and Brown and co-workers,[9] in rabbits and in monkeys irradiation was especially injurious to the rods and to a lesser degree to the cones. The nuclei of the outer nuclear layer were killed in most

FIG. 5. *Lens and Retina.* (*A*) Part of the section through the eye of animal (II.15) fixed 43 days after irradiation with 3,000 r and 75 days after hatching. Penetration of macrophages into the lens. Photomicrograph ×510. (*B*) Part of the section through the eye of animal (II.17) fixed 59 days after irradiation with 3,000 r and 91 days after hatching. Accumulation of the macrophages in the lens. Photomicrograph ×510. (*C*) Part of the section through the eye of animal (II.22-A) fixed 170 days after irradiation with 3,000 r 194 days after hatching. Rudiment of the retina (R). Photomicrograph ×450. (*D*) Part of the section through the retina of animal (II.64) fixed 28 days after irradiation with 6,000 r and 53 days after hatching. Degeneration of the retina. Photomicrograph ×450. F—folds of the lens membrane; G—giant nuclei; M—macrophages; P—pigment cells; PN—picnotic nuclei; R—retina.

cases. All of the above papers show that the rods and cones and their cell bodies in the outer nuclear layer were the most sensitive to irradiation.

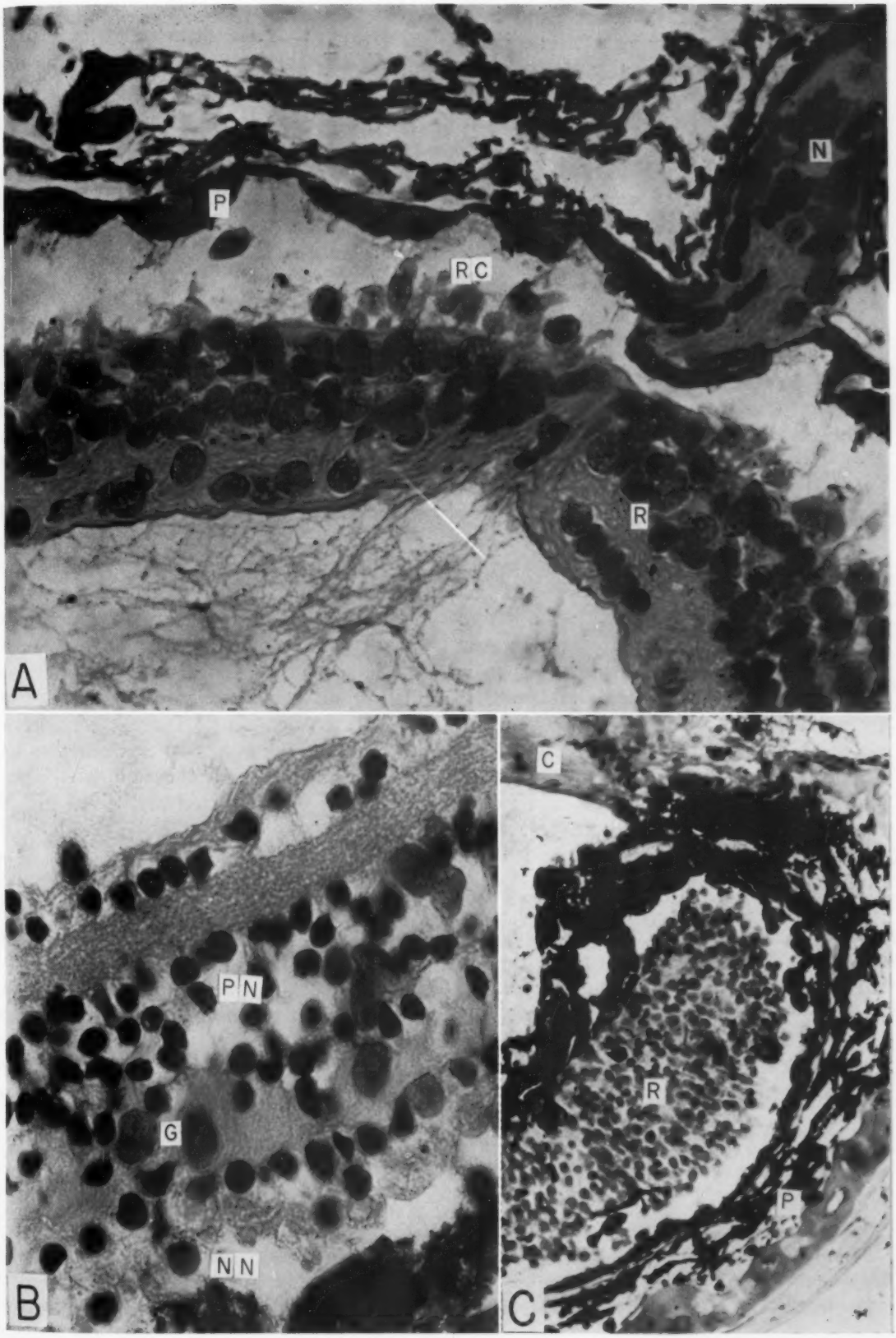
Allen and Devick,[1] however, found no injury to the rods and cones and their cell bodies in the outer nuclear layer of Bufo, while on the other hand, the inner nuclear and ganglionic layers showed a very high degree of damage. According to Rugh *et al.*[25] after irradiation of amphibia the rods and cones "are separated from the pigmented layer, but are not individually damaged as are the neuroblast cells, what we call the formative cells, or the embryonic cells in the retinal layer. The rods and cones are apparently not relatively sensitive or delicate. Edema develops and separates the rods and cones from the outer pigmented layer. But I do not believe the cells of this layer are as easily damaged as other cells."

Several months after irradiation of the head of axolotl with 3,000–6,000 r, all animals became blind. But the causes of this blindness differed in various instances. In most cases blindness was due to damage of the lens and cornea. In some cases (Table 1) if the lens was normal, it was the result of serious damage of the retina.

The radiosensitivity of the lens of mammals is well established. Many authors have described the formation of cataract after roentgen irradiation[21] and atomic bomb explosion.[13] Damage of the lens was noted by various investigators after various periods of time following irradiation. For example, Puntenney and Schoch[22] observed granules and vacuoles in the eye of rabbits six to seven weeks after irradiation with 4,000 r. Von Sallmann[30] noted histologic changes in the eye of rabbits as early as one week after irradiation with 2,000 r. After two and three weeks these changes became more pronounced. Swelling and disorganization of lens fibers were usually observed after changes in the cell nuclei had advanced. According to Richards, Riley and Leinfelder,[23] formation of vacuoles in the rabbit lens was observed four months after irradiation with 11,000 r. Leinfelder and Kerr[16] described the development of opacities in the lenses of two children after a latent period of two years following roentgen therapy. In these cases swelling of the lens fibers, separation of fibers by large and small vacuoles, and formation of small homogeneous globules were seen. According to Poppe[21] the roentgen cataract is due to the effect of rays on the lens epithelium. The smallest dose producing pathologic lens changes is 250 r. Von Sallmann[29] observed almost complete disappearance of dividing cells thirty minutes after irradiation of the rabbit's eye with 1,500 r. This total inhibition lasted three to four days. Recovery of mitosis took place in the next four days.

From a description of histologic changes which occur during the development of roentgen cataract in mammals, it is clear that they are very similar to those that we observed in axolotl. From this we can conclude that in axolotl we have also observed the development of cataract. But it is necessary to note that in mammals complete disappearance of lens was never described. This probably is connected with especially great phagocytic activity of giant cells (macrophages) in axolotls. The macrophages, which were never observed in the normal lens, accumulated in large numbers inside the lens after irradiation. Phagocytic activity was noted in our previous investigations after irradiation of regenerat-

FIG. 6. *Retina.* (*A*) Part of the section through the eye of animal (II.102) fixed 77 days after irradiation with 6,000 r and 102 days after hatching. Photomicrograph ×450. (*B*) Part of the section through the eye of animal (II.26) fixed 247 days after irradiation with 3,000 r and 272 days after hatching. Photomicrograph ×510. (*C*) Part of the section through the eye of animal (II.23) fixed 170 days after irradiation with 3,000 r and 194 days after hatching. Photomicrograph ×160. C—cornea; G—giant nuclei; N—optic nerve; NN—normal nucleus; R—retina; RC—remnants of rods and cones layer of retina; P—pigment cells; PN—picnotic nuclei.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ing limbs of the adult axolotl[3] and in irradiated tails of the young axolotl.[2] Phagocytosis after roentgen irradiation was observed not only in tissues of amphibians, but also in white mice, rabbits and in the tissues of human subjects (Warthin,[32] Warthin and Case[33]; see also Maximow[18]). Likewise, it was noted after irradiation of embryos of white rats in central nervous system, thymus and mesoderm and after irradiation of embryos of guinea pigs.[14,15] According to Rugh, Levy and Sapadin[25] in irradiated hamster " . . . . there is widespread evidence of macrophage and reticular cell ingestion of erythrocytes. The phagocytes contain numerous normal and ghost erythrocytes." Rugh and Wolff[27,28] also noted phagocytosis in the irradiated eye of the mouse. In insects phagocytosis was described after irradiation of embryos of grasshoppers.[10] Observations of Cramer[11] show that the damaged cells attract macrophages in irradiated mouse carcinoma and, therefore, the irradiation induces a macrophage reaction in the treated tissues. According to Withers[34] the dead cells in irradiated tissues in mammals are removed by autolysis and phagocytosis. Tzuzuki[31] noted that after irradiation of the rabbit "many phagocytes appear in the lymph sinus and are seen to have absorbed chromatin granules and erythrocytes. From this it may be concluded that a destruction of nuclei and degeneration of the erythrocytes has occurred, either in the circulating blood or in the lymph. These phagocytes may come chiefly from reticulo-endothelial cells and histiocytes, partly from the polymorphonuclear leucocytes. During the most active period, some of the phagocytes may devour so much that they degenerate and may, thus, be destroyed."

SUMMARY

1. After irradiation, the entire cornea never disappeared. In 38 per cent of all cases the cornea was damaged. In some cases the substantia propria was much thicker than normal. The damage of corneal epithelium was different in various cases. The reduction of the number of cell layers was typical. Simultaneously, the development of giant cells and Leydig's cells could be observed. In 29.5 per cent of all cases the epithelium of the cornea disappeared completely, being replaced by typical skin epithelium with large numbers of Leydig's cells.

2. The lens was the most sensitive organ to irradiation. The development of roentgen cataract was observed. Slight damage was noted in 4.6 per cent of all cases. In this damage, formation of granules, vacuoles and spheres of different size was typical. Moderate damage was noted in 22.1 per cent of all animals. Great disturbances occurred in all peripheral portions. More than one-half of the lens was completely transformed into a globular mass. The lens fibers were partially dissolved. Only the central portion of the lens retained its original structure. Serious damage occurred in 28.8 per cent of all cases. This damage was characterized by almost complete disappearance of the normal substance of the lens. The most resistant was the lens membrane which formed many folds due to loss of lens content. A great number of giant cells (macrophages) was noted in the body of the seriously damaged lens. These giant cells phagocytized and dissolved the lens fibers.

3. In the retina, the rods and cones layer was the most sensitive. In 30.6 per cent of all cases this layer was completely absent. In 33.1 per cent it was damaged and in 36.3 per cent of all animals it had a normal appearance. Other layers of the retina were much more resistant to irradiation. Complete absence of the retina was not observed and in 15.7 per cent damage of all layers of the retina was noted. In 84.3 per cent the appearance of retinal layers was normal.

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THE JOY AND COST OF OFFICE RADIOLOGY*

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THIS presentation is especially directed to the young radiologist just finishing his residency and about to select his field of practice. I invite him to look up briefly from Burneice Larson's column, shake the gold dust out of his eyes and reconsider a question: why did he become a doctor?

Was it to qualify for a high salary in a Persian oil field? Was it to confirm the effects of ionizing radiation on the broad bean root? Was it to hold down a hack job in the back room of a great medical center murmuring into a dictaphone an opinion that may never be read?

Or was it to choose and serve a community as an independent physician and do everything in his power to heal and comfort a group of distressed human beings?

If *this* was ever his intent, I beg him to resume it and to enter the general practice of radiology in an office with a partner, or better yet, alone. I promise him great pleasure in his work, hours of the deepest despondency and a place near the heart of medicine, close to every problem in the healing art. If he is thirty years old today, he can look forward to as many more years of satisfying practice.[2] And, the agonizing wails of a few cynics notwithstanding, it will not take him a lifetime to pay for his equipment.

There are relatively few radiologists in office practice—only about 17 per cent of those in the United States.[4] This is a surprisingly small figure if one considers that only in Canada and the Americas have doctors retained enough freedom and earning power to make possible such a venture. How many have failed? I have not been able to find out, but I know of only one in my own city in recent years. It is instructive to recall the results of a survey conducted by the American College of Radiology in 1955.[1] Out of 104 radiologists in private practice who were queried, 88 per cent reported that they enjoyed more security in private practice than if they had engaged exclusively in hospital practice. Two-thirds of these men stated that they could make an adequate living with their office practice alone. More than half asserted that they had assumed the risks of office practice in search of independence and security.

The American College of Radiology includes among office practitioners those radiologists who work in hospitals and send out their own bills. In the present discussion office practice means a system of radiology maintained entirely outside a hospital. It further means that every patient entering the office is examined by a radiologist or treated by him and *not* by a technician. This is my most basic stipulation.

I am not an authority on office practice and do not pretend to be. In fact I am a barefoot rookie, as my experience covers no more than two years. I have made every mistake that can be made, including a complete inventory of my film bin with all the lights on to see if there were enough 14 by 17s to last me through the week! But I enjoy the work. There is little written about it, and while my own blunders are fresh in my mind it will do no harm to tell you what details seem to be important.

It is well to scout out a prospective community with care before making any move or even forming any plan. At the start one will be influenced by such personal considerations as climate, friends, industry, proximity to or deliverance from family and relationships with other doctors. There is a great deal to be learned from books but much more from conversations with people. Begin with the manager of the bank. You

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TABLE I

LOCATION OF ONE OFFICE FOR THE PRACTICE OF RADIOLOGY

Drawing area:	Half of a city suburban-residential ward; approximately 5 square miles
Population:	114,197 in 1950[4]
Hospitals:	2
Doctors:	Approximately 228
General practice:	68
Practice limited:	160
Radiologists:	8
Office:	2
Hospital:	6
In 1955:	36,214 examinations[5]
	5,329 deep roentgen-ray treatments
	1,477 superficial roentgen-ray treatments

are going to need his help, believe me, and you may be surprised to discover the extent of his knowledge and his skill in calculating the odds.

Talk to other radiologists whether you know them or not. Trust them. Disregard the loose talk you've heard about competition. You are in a growing specialty; have confidence in it and in yourself. With very few exceptions you will find your colleagues frank, hospitable and anxious to help you. You may even be as touched as I was to find the wife of one of them among my first patients.

Before choosing an office location, it is worthwhile keeping four physical considerations in mind: (1) Is there sufficient parking space close by? (2) Is there convenient bus or streetcar service? (3) Will your home and office be close enough to each other to allow you to do emergency work at any hour? (4) Are you close to other doctors? In spite of the proverb you will do well to keep your better mousetrap out of the wilderness.

My own geography is summarized in Table I. I work in a middle-class to well-to-do suburban, residential city ward with a population of about 115,000.[5] It is growing slowly. Most of my patients live in the northern half of the ward in an area of roughly 5 square miles. There are two hospitals not far away, several convalescent homes and about 228 doctors, most of whom are specialists. During the year before I entered practice there were 8 radiologists in the district. The 6 in hospital practice reported a total of about 36,000 examinations annually.[3]

One must decide very early whether to buy, rent, convert or build. Each plan has its advantages, but in choosing you will be influenced chiefly by the amount of cash at your disposal. Right at the start you must pluck one crucial figure out of the crystal ball: how many patients do you expect to take care of every day? Not the smallest number; the greatest. This is a good time to use a little hope. Try not to skimp, for most radiologists are clamoring for more room. The most expensive way of doing the job is peacemeal; the cheapest is the boldest. Groover, a pioneer in the economics of radiology, pointed out that "a radiologist is more likely to reach the peak of his earning capacity after 15 years of practice than he is before."[6] Take comfort from this at the beginning. If the rooms seem draughty just think how crowded they will be in only fifteen years!

How much space will you need? According to some estimates you can get by with a minimum of 50 square feet per patient per day, but this is probably not enough, and 100 square feet is a more reasonable figure.[7] In Philadelphia the annual rent of air-conditioned space runs from $4.00–$5.00 per square foot. A bit less in the suburbs. It thus follows that if you expect 10 patients a day you must expect to pay an annual rental of between three and four thousand dollars.

If you can afford the initial cost, the ideal way of creating your office is to build it. The cost of doing this in Philadelphia is between $18.00 and $22.50 per square foot. Mine, which is air-conditioned, cost $21.00 per square foot, including the purchase and installation of lead sheathing for the walls. When the cost is spread over twenty years, it is probably no more expensive to build than to rent, and it is a great deal more satisfactory.

Consider these questions in your office plan:

1. How many steps will the patient with the pinned hip have to climb to get into your office?

2. Can a wheelchair or ambulance litter travel from the front door to your examining room?

3. Can you and your secretary telephone in privacy?

4. Is there more than one toilet? A radiologist in New York had but one. On a certain morning he found the door bolted and was soon afterwards seen escorting his patient, a maharajah, up two flights of stairs and through a colleague's waiting room, dragging an enema tube and quivering white line of barium.

5. Where will your patients sit during a long examination? Have you provided any space out of a draught, with enough light to read by and sufficient privacy to keep the victim's gartered calves out of the eye of every mailman, salesman, elevator operator or trash collector who happens by?

6. What color are your walls? When I asked an artist how he gave his canvasses a quality of the most hopeless despair he said, "I use glacial shades of blue and green commonly found on the walls of orphanages, hospitals and doctor's offices." Light shades of yellow, peach and beige are cheerful, and a pink light bulb in the dressing room adds grams to your patient's hemoglobin.

Equipment is expensive. In Table II I have listed its approximate cost in 1958 in Philadelphia. I am indebted for these figures to the local representatives of Picker, General Electric, Standard (Franklin) and Westinghouse Companies. The estimates apply to the cost of purchase and installation of heavy *or* medium weight apparatus. I emphasize that the figures are exceedingly rough. They do not always apply to exactly comparable quality of machinery, and any company may be willing, for reasons of its own, to vary its prices or terms to suit a particular individual. The rates, then, are intended only to give a range of cost. In Table II the letters A, B, C and D do not necessarily relate to the companies in the order listed above.

The estimates cover the following equipment: (1) a 200 milliampere fluoroscopy-roentgenography unit complete with motor-driven table, cables, control panel, two tubes and a reciprocating grid; (2) essential darkroom and roentgenographic acces-

TABLE II

ESTIMATE FOR THE COST OF TECHNICAL EQUIPMENT FOR A RADIOLOGY OFFICE IN PHILADELPHIA IN 1958

	Company A	Company B	Company C	Company D
Diagnostic	$13,400	$11,650	$12,750	$11,250
Darkroom and Accessories	1,550	1,000	2,000	1,500
Therapy	16,064*	13,500*	12,114†	9,000†
Tax (3 per cent)	930	785	806	652
Total	30,923	26,935	27,670	22,403
Optional				
300 ma.	1,200	1,800	1,000	1,400
Impulse timer		1,000	1,100	600
Spot photo timer	810	726	1,150	1,100
Body section	1,350	1,700	1,225	1,300

* 250 kv. peak.
† 220 kv. peak.
All prices refer to cash payment.
Protection: Impossible to estimate until exact location is established. Sheet lead sells for 30¢/lb. If 1/16" thick will weigh 4 lb./sq. ft.; if 1/8" thick will weigh 8 lb./sq. ft. In diagnostic room must extend up 7 ft. from floor; to ceiling in therapy room. One rule of thumb: take total cost of lead, multiply by 2 (non-union) or 2½ (union), and the sum of these figures will give the approximate cost of purchase and installation of lead.

TABLE III

TERMS OF PURCHASE OF TECHNICAL EQUIPMENT OBSERVED BY FOUR COMPANIES

	Discount for Cash	Per Cent Down	Months to Pay	Rental
Company A	0	20	36	2¾ per cent per month. Minimum: 24 months. Covers all equipment
Company B	0	20	36	2¾ per cent per month. Covers all but darkroom
Company C	0	20	36	None
Company D	0	20	36	2½ per cent per month

Carrying charge: 5 per cent.

sories; (3) therapy equipment with a potential of between 220 and 250 kv. peak, cones and treatment couch of simple design; (4) some idea of the cost of protection, the range of which varies enormously.

The total cost lies between $22,000 and $31,000. The average is about $27,000. No fancy gadgets are included. There is a considerable range in the cost of therapy machines if one prefers 250 rather than 220 kv. peak. Constant potential adds from 5,000 to 7,000 dollars to the therapy bill.

A 200 milliampere diagnostic unit was specified, since there is reason to hope that with faster film and screens and more sensitive developing solutions a generator such as this would suffice for most office procedures. A 300 milliampere installation would be more flexible and perhaps more economical in the end for it would not be in constant use at its peak rating.

In Table III are listed the terms of purchase. The usual contract calls for an initial down payment of 20 per cent and the balance to be paid in three years. This is not long, but it's unanimous! As a rule all equipment except glassware is guaranteed for six months.

Whatever else it may be, radiology is one long exercise in economics, and not a day passes when one does not face the problem of costs. These can readily be analyzed and set forth in neat columns, but it is risky to compare one man's figures with another's as accounting is an uncommonly private and devious form of cunning.

With this warning I invite you to consider my earnings and expenses during 1957, the first full, calendar year I was in office practice. These are indicated graphically in Figure 1. The open block represents my total, earned income in that one year. The block of solid black beside it represents my total operating cost for the same year—equal to 54.4 per cent of earned income. Above operating costs is indicated depreciation calculated, in this instance, at the most rapid rate allowed—10 per cent annually on equipment and 5

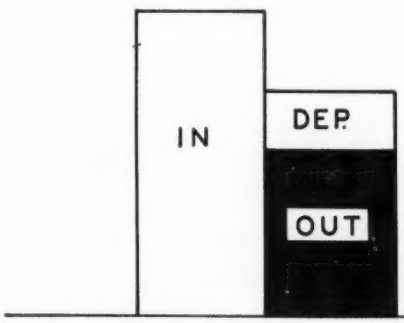

FIG. 1. Comparison of income and expenses during first calendar year of office practice. The open block labelled "IN" represents the entire earned income. The block of solid black labelled "OUT" represents total operating cost. Above this an open block labelled "DEP." represents depreciation calculated at the most rapid rate permitted. The sum of the operating costs and depreciation equals 75 per cent of earned income.

per cent annually on the building. During that year the sum of operating cost and depreciation amounted to 75 per cent of earned income.

It is convenient to divide operating costs into two groups: the fixed and the variable. Fixed costs include all expenses necessary to keep an office open—rent, interest on loan, wages and utilities. They are influenced to some degree by the season, but when charted rather tend to follow the gradual slope of inflation.

Variable costs are determined by the volume of practice. As the number of patients increases so does the amount of linen, writing paper and barium used. The total overhead is the sum of these two fractions plus amortization or depreciation.

In Table IV are listed, in terms of percentages, the components of my own operating costs in 1957. Depreciation stands at the top only because I have chosen to calculate it that way. Next comes wages, and so on. Major expenses, such as films and chemicals (17 cents out of every dollar spent) come as no surprise. These, as well as a few sample, miscellaneous costs, are listed in Table V—the matter of taxes, for example, and what one must spend to fill a 10 gallon developing tank, or rent a clean pillow case, or flavor a cup of barium to the point where you would not mind too much swallowing it yourself. Certain small, constant economies will save a great deal of money through the years—the use of

TABLE IV

OPERATING COSTS DURING FIRST YEAR OF PRACTICE, EXPRESSED AS PERCENTAGES OF THE WHOLE

	Per Cent	
Fixed Expenses		
Depreciation	27.71	
Salary	18.41	
Interest on loan	8.26	
Utilities	7.68	
Taxes (state and local)	4.73	
Cleaning	4.26	
Insurance	2.96	
Miscellaneous	2.81	
Automobile		
Accountant		
Drugs		
Magazines, etc.		
Medical societies and medical journals	1.57	
		78.39 per cent
Variable Expenses		
Films and chemicals	17.31	
Laundry	2.64	
Stationery	1.30	
Delivery charges	.36	
		21.61
		100.00 per cent

TABLE V

SAMPLE OF MISCELLANEOUS COSTS TO CONSIDER

Taxes	Insurance
1. Federal income	1. Malpractice
2. State personal property	2. Fire
3. City net profits	3. Compensation
4. Social security	4. Liability
5. Unemployment compensation	
6. Mercantile license	
7. Mercantile tax	
8. School tax	
9. Real estate tax	
10. Parking lot tax	
11. Narcotics license	
12. Physician's registration	
13. Sales tax	

Other Expenses

Item	Cost
Film	
1 8×10 inch	$ .25
1 10×12 inch	.35
1 14×14 inch	.56
1 14×17 inch	.66
Laundry	
1 hand towel	$ .06
1 sheet	.20
1 pillow-case	.10
1 patient gown	.27
Solution	
10 gal. developer	$ 8.49
25 gal. fixing solution	17.87
Stationery and postage	
For 1 patient	$ .12
Grape juice	
To flavor 1 barium meal	$ .07

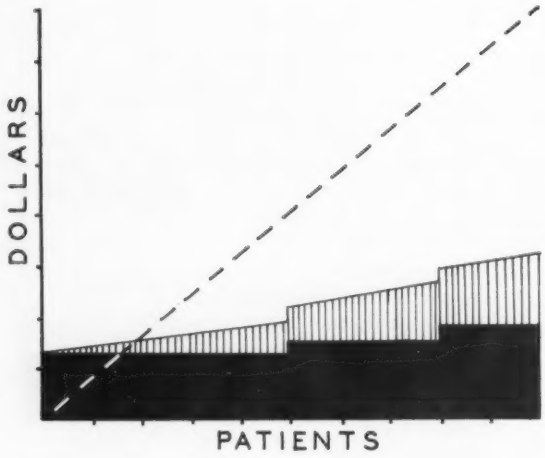

FIG. 2. Relationship of patient volume to operating costs. The section in solid black represents fixed operating costs. The vertical grid above it indicates variable operating costs which increase with growth of practice. The broken, diagonal line represents the product of number of patients multiplied by the average income per patient. The latter is a surprisingly constant figure month by month.

14×14 inch film for chest roentgenography, for example. With care in positioning, the great majority of adult chests will fit on such a film at a target-film distance of 72 inches. And you do not need a special cassette if you will slide the film into a 14×17 inch cassette and just remember which end is which.

Clearly, the awkward time is at the start when there is a high overhead and no patients. For days you will sit around getting the feel of your waiting room, and you may wonder if the telephone line has been cut. You may discover, as I did, that this is a perfect opportunity to learn to play "Onward Christian Soldiers" and "The Wearing of the Green" on a small accordion. Eventually, a few patients will begin to trickle in, most of them out of curiosity. One lady confessed to me that she would have come in much sooner if she had not been so afraid of the fall-out in my therapy room. With these early, welcome, charter subscribers you will be in business, and running it for yourself.

The relationship of patient volume to operating cost is an interesting one, and has been shown graphically in Figure 2. Fixed costs are represented in solid black, with step-like increases which result when additional wages are paid out to new employees. The vertical grid represents variable costs as they increase with patient volume and ride on top of the fixed steps in the manner indicated.

The broken line indicates the product of number of patients multiplied by the average income per patient. This is a curiously constant figure, varying so little from month to month that I think it is safe to multiply it times any hypothetical number to project a rising line. The line begins at zero, eventually passes the cost of overhead and soars into infinite space. The distance between the broken line and the top of the grid represents profit. There are no absolute values indicated in Figure 2 because they are irrelevant. The point is this: as in any other business, profit rapidly increases with volume of work once a certain threshold (operating cost) has been passed.

Here is an example. During my second year of practice I saw 23 per cent more patients than in the first year. My expenses remained almost unchanged—actually they were 6 per cent less. But with an increase of only 23 per cent in patient visits my profit increased by 129 per cent.

What are your chief assets in office practice, especially in the beginning when you need them most? The greatest, and the sum of all others if you will be alert enough to exploit it, is flexibility. It is a complicated force made up of simplicity, speed and a constant awareness of the needs of the patient. Within the limits of your own conscience and desire for accuracy, you need consider only two people: the patient and the referring doctor. No one else matters. You have time. Time enough to be thorough; time to listen; to look up a reference; to examine every wet film before the patient dresses and thus reduce virtually to zero the embarrassing number of recalls that plague a busy department. After a little practice with your appointment book you learn to space patients so that no one

need wait—people object more to waiting than to the size of their bills. Being independent of a fixed routine you find it possible to do a gastrointestinal series at 9:00 P.M. or an intravenous urography at 11:00 in the morning. You accommodate the patient *now*. You may be surprised how quickly he responds.

Here is a paradox: when you have time you can make haste. There are so few distractions. Take the matter of reports. There are few things more perishable than a radiologist's report. It spoils quicker than fish. It keeps poorly on a table, embedded in wax, in a basket or even scratched on a pad as a wet reading. Most referring doctors will take your reports just about as seriously as you do, but it is the final, written, signed report that counts, and the examination is not truly over until this is in his hands. The burden of delivery is yours.

Figure 3 is a photograph of a good friend and loyal ally. He thrives on responsibility, and he has a cousin in every community if you will only look for him. Dick is a career messenger and delivery boy for a local drug store. Within four hours of any roentgenologic examination, he will deliver the roentgenograms and report to any doctor within a radius of 1 mile of my office for a flat fee of 25 cents an envelope. My wife and I, being poor bicyclists, deliver reports by automobile to any point within 5 miles on the day of examination. Every penny spent on this service is amply repaid.

In an office, with so few people to please, you can keep things simple. No forms in triplicate, budget committees, board of managers and tempests of departmental rivalry. When you need a rubber band, you just buy one. And there are so many wonderful things you don't need. You don't need a dictaphone. When reports are written in longhand and copied on a typewriter, they become marvels of brevity and conciseness. You don't need a secretary, though a good one soon pays for herself. If you have a secretary, you don't need a technician as long as your weekly case load is below 45. Many patients will be enchanted to learn that you know how to turn on the machine, put them in position, push the button and develop the film yourself. Is not this the laying on of hands? Why should we shrink from it? It is this quality of total responsibility—the willingness and ability to play every instrument in the band and conduct as well—that is the greatest joy in office practice. It is called craftsmanship. It is among our most ancient and satisfying impulses, for it sets us free.

FIG. 3. Dick.

Individual care can include comfort for the patient, and it is not expensive. It is a matter of soap, clean pillow cases, courtesy and ventilation. When a patient has wrestled through the night with 2 ounces of castor oil and arrives hungry and hostile at your examining table at 8:00 A.M., it costs very little to give him a piece of toast, cup of coffee and a boiled egg after urography. You need a toaster, a percolator, a hot plate and a window to let the smell out. Your secretary can do it. Your patient will never forget it.

It is as well to plan a traffic pattern before crowding becomes a problem, for patients appreciate conduct through an examination with as much privacy and as little backtracking as possible. A good flow plan begins with a good *floor* plan. It is closely related to your appointment book, telephone, therapy transformer and the thermostat on your darkroom tanks. All

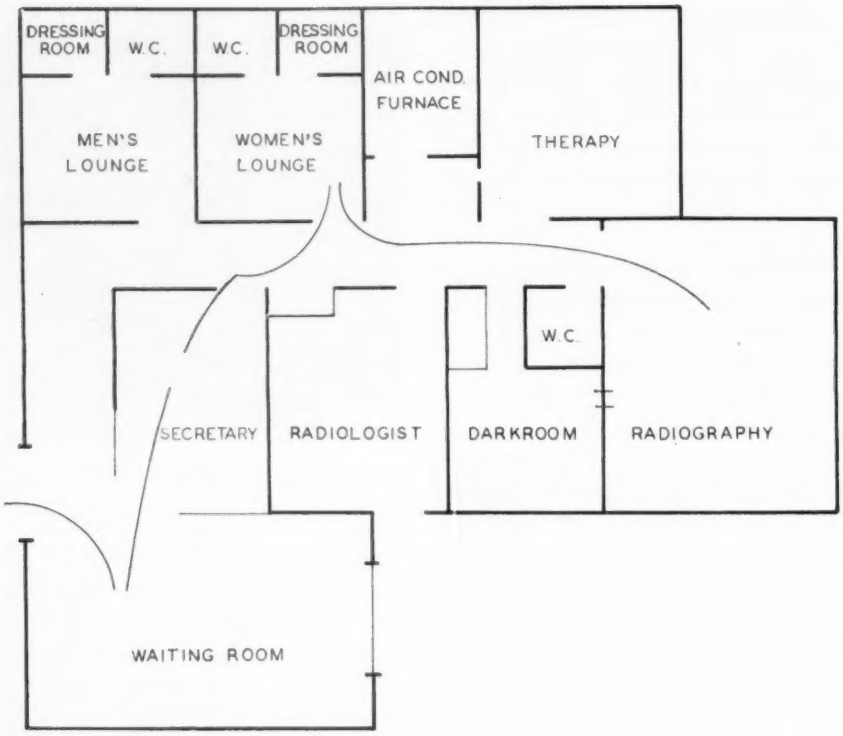

FIG. 4. Floor and traffic plan of an office. The slender, curved line indicates the path of a woman patient entering for a relatively simple examination.

of these must mesh, but the plan can be no better than your secretary. A good one must have the instincts of a traffic officer, an ability to shepherd through with tact not only the late patient but what is sometimes more exasperating, the anxious, early patient.

My own plan is illustrated in Figure 4. The waiting room is reserved for clothed patients waiting to register or already through their examination. The secretary's cubicle was designed with glass on two sides above waist level, which permits her to see everyone who comes in the front door. All space between the front door and the dressing room is under her control, and I try to stay out of it. Between dressing room and roentgenography or the therapy machine is my territory. It simplifies our jobs to have these boundaries clearly defined.

About 8 per cent of my work is done at night. This is not a high figure, but it is an important one. Many patients can come at no other time, and as most of the doctors in my community have evening office hours I try to synchronize my own with theirs. More than once in the evening an emergency patient has opened a long, beautiful friendship between another doctor and myself.

One warning may not be amiss: you cannot go it alone in an office, even with a partner. No matter how busy you are, if you are isolated from teaching and from hospital contacts you will stagnate in days. A radiologist can do nothing in an office that cannot be done in a hospital, but a vast amount of exciting work is done every day in hospitals that cannot be done in an office. Arteriography, for example, and experimental methods of diagnosis and therapy. You must have a hospital affiliation —an honorary one will do—not for the sake of your pocketbook but for the sake of your soul. You need the stimulus of other minds and the discipline of contrary views. One of the real costs of office practice is an occasional, overwhelming sense of isola-

tion. This can only be relieved by communion with other doctors and a willingness to follow every patient to operation or autopsy. Look to the hospital for your consultants who will save you many errors in judgment, especially with therapy patients.

What do you get out of it? What are the rewards, the joys, if you please?

To speak first of money, when you first begin you can expect to run in the red, at least for a time. In my first month of practice I lost $880. In my second, $440. In my third, $169. Since then I have made money each month—enough to pay back a good part of my debt to the bank and to keep a few dollars. I am keeping more every month.

During my first year I did between one and two thousand examinations and treatments. The distribution of my work is shown on Table VI. Chest, bone and joint examinations made up the major fractions, and the digestive tract added a bit more. In Table V my figures are listed beside those of Donaldson's[7] series of almost half a million to show how constant the proportion can be.

About 55 per cent of the visits to my office were made by women, 35 per cent by men and 10 per cent by children. Each of them picked me, or were referred to me out of free choice. They are my patients in the flesh, not as film images, and each of them knows my name. This is one of the great satisfactions of office practice.

Therapy represented only 16 per cent of my work load, though it demanded more of my time than this figure would indicate. I was reluctant, at first, to invest a considerable sum in a machine whose capacity to cure I honestly doubted. But I have never regretted my decision to put in a therapy machine. Most of my patients were treated for benign disease. It is still too soon to know what help, if any, I was able to give those with cancer. But I have learned that in the palliative treatment of cancer, as so much of it is, the quality of compassion is no less important than the quality of the beam. One's relationship with patients in the late stages of their disease is a peculiarly warm and intimate one. In such a situation a doctor can learn so much of courage and tenacity that he often gets as much as he gives, and in the mere acts of listening, touching and trying to understand he can wonderfully reinforce his machine.

Table VI

DISTRIBUTION OF WORK IN ONE YEAR; COMPARISON OF A SHORT SERIES WITH A LONG ONE

	Office Per Cent	Donaldson* Per Cent
Bone and Joint	39.2	33.2
Chest	31.1	33.85
Gastrointestinal, Esophageal and Gallbladder	19.5	17.78
Genitourinary	2.3	5.65
Skull and Miscellaneous	7.9	9.44
Therapy	15.9	16.2

* Based on 496,403 examinations.

There are few published statistics about the source of patients referred to a radiologist's office. These must vary so much that perhaps no figures are of a great deal of value, but mine are listed in Table VII to satisfy the curious. General practitioners and internists were the greatest source of referral, sending almost 74 per cent of my patients. Surgeons sent relatively few, less than 3 per cent. An appreciable number, 3.4 per cent, (and this group has steadily

Table VII

SOURCE OF PATIENT REFERRAL DURING FIRST YEAR OF PRACTICE

Internists and General Practitioners		73.6%
All Others		26.4
Orthopedists	9.5	
Pediatricians	3.7	
Otolaryngologists	3.6	
Self-referred	3.4	
Urologists	1.6	
Ophthalmologists	.4	
Obstetricians and Gynecologists	.3	
Osteopaths	1.5	

increased), would telephone and say, "Dr. Smith wants me to have a chest film, and he doesn't mind if I come to you." It is well to hold these self-referred patients in particular respect. As a rule they are loyal and militant supporters, and from almost every one of them will come another patient or, better yet, another doctor. Most patients are referred by doctors, but a surprising number of doctors are referred by patients.

Dr. Smith may approve of your service, or he may be indifferent to it. He has his own tastes, standards and prejudices, and you must remember that he does not owe you a living. Quite likely he will prefer the convenience of a hospital department where he can make rounds with his films as he would with his patients, in familiar and sympathetic surroundings. This system has much to recommend it, and it resists change. But if you give Dr. Smith prompt and accurate service, and if you give his patient courteous, efficient and personal care, he cannot always ignore you.

Try not to take for granted one of the most important people in the whole plan—the radiologist's wife. If she believes in what you are trying to do you will never fail. You will find her the constant, elusive force, appearing on none of your charts but influencing them all. Worth rubies.

"What about Blue Cross?" It is impossible to avoid this question, for it is part of a growing concept of prepaid insurance that is affecting every branch of medical practice. In Philadelphia during the past eighteen months "Blue Cross" has become a shock phrase, and its mere mention has thrown some of our most equable citizens into livid indignation or stunned silence. As my office was being built I was warned by one of our most informed radiologists that Blue Cross would have my scalp in no time. Apparently I was being watched.

I need not trouble you with my own opinion of this most involved problem except to point out that I have not been scalped. Undoubtedly I have lost patients who were admitted to hospitals for diagnostic purposes. There are signs that such unnecessary hospitalizations are to be controlled, or at least reduced, and I believe the radiologist in office practice will gain considerably from these measures. In July of this year Philadelphia Blue Cross offered, in connection with a rate and benefit increase authorized by the State Insurance Commissioner, both the standard contract and a new Co-pay contract. The latter closely resembles the Blue Cross-Blue Shield Master Steel Plan which has been in operation in certain industrial centers for about two years. Each Blue Cross Co-pay contract carries a Blue Shield rider under the terms of which each subscriber is permitted $75 worth of diagnostic radiology each year. There is a $5 deductible clause. The program has been in effect only a short time and is by no means ideal, yet it does give the ambulatory patient, early in his illness, the choice of diagnostic radiologic service either in the doctor's office or in the out-patient department of the hospital. This is a promising beginning which should reduce unnecessary hospitalization and direct the ambulatory patient back to the doctor's office.

When I review my title and read over what I have written I find that I have said far more about cost than joy. Costs, being material, are easy to analyze and tabulate. But anyone who tries this work will discover, on the first day, all that makes the costs worthwhile: the exciting combination of medical, artistic and business disciplines that radiology so uniquely offers. He cannot avoid the warmth of close relationship with people in need of help. He is responsible. Of course he will run risks—who doesn't? He may remember what Thoreau said, "A man sits as many risks as he runs."[8] But when life is so short, why sit? Why not run?

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EDITORIALS

ADDRESS OF WELCOME*

By MAJOR GENERAL JAMES P. COONEY, MC
Deputy Surgeon General, United States Army
WASHINGTON, D. C.

Doctor Scott, Members of the American Roentgen Ray Society, and Guests:

It is my privilege and very great pleasure to welcome you to this meeting. I hope that your visit here in Washington will be both pleasant and profitable. I know that this meeting will be a most productive one.

Many nice things have happened to me during my life, and the invitation to give you this address of welcome is one of the nicest. This is another indication of the splendid relationship which exists between civilian and military radiology. It has always been thus, and I am sure it will continue to be so.

For the benefit of some of the younger generation who are perhaps not too well acquainted with the history of Army radiology, I have perused some of the literature in the Reference Library of the Office of The Surgeon General and excerpted the following certain items of historical interest.

Edgar E. Hume:[1] The Spanish American War began soon after the discovery of roentgen rays by Wilhelm Conrad Röntgen. Army medical officers became immediately interested in this new discovery and Surgeon General Sternberg gave his enthusiastic support to the use of roentgenologic equipment in the field and in the hospital. For the first time there was a practical opportunity for the use of roentgen rays in locating bullets and other missiles in the body.

[1] HUME, EDGAR E. Victories of Army Medicine.

The first medical officer in the Army to die as a result of exposure to roentgen rays was Col. Eugene Garland Northington (1880–1933). The following tribute was given by Brig. Gen. Edward L. Munson, U. S. Army, Ret.

A generation ago, when the roentgen ray was a recent discovery, Dr. Eugene G. Northington of the Army Medical Corps was one of the early pioneers in its study as to its applicability to suffering humanity. Little was then known as to the possible benefits of this roentgen ray. Perhaps less was known as to its insidious dangers that resulted from inadequate protection—and to the latter Dr. Northington was one of the earliest victims of the medical profession.

More than twenty years ago, he and the writer served together. His hands, burned as if by fire, even then showed the development of cancerous nodules; which, to both of us as doctors, had only one significance—one ending. Yet he faced the future undaunted, without repining, and interested only in that what was left to him of life should be turned to the advantage of others.

While he was retired for disability in 1920, he sought for and received assignments to active duty in the teaching of the coming generation of young doctors in the Medical R.O.T.C., and in work with the recruiting service. Finally he could do no more, and about a year ago entered Letterman Hospital to wait for the end, setting a high standard of cheerful unselfishness to other less grave cases.

During a term of many years, Col. Northington underwent seventy-six surgical operations for the removal of successive cancerous growths. Fingers, hands and both arms were ultimately lost, and he became wholly dependent on the ministrations of others. Finally, growths extended through the

* Presented at the Fifty-ninth Annual Meeting of the American Roentgen Ray Society, Washington, D. C., September 30–October 3, 1958.

body, and surgery could do no more.

The Army Medical Corps, and the medical profession at large, may well be proud to have the name of Col. Northington on its rosters. A medical martyr—he was also the bravest of soldiers.

There have been other martyrs in the pioneer work in military roentgenology who have contributed experience and knowledge in that specialty. Frederick Henry Baetjer (1874–1933), who volunteered for service in World War I despite already apparent roentgen-ray injuries, served as lecturer in military roentgenology at a special school established by the Medical Department for training diagnosticians and technicians.

L. Middleditch:[2] Eugene Wilson Caldwell was one of the first radiologists to join the Medical Reserve Corps. One of his final scientific contributions and his major war work, his second stereoscopic fluoroscope, was used by the Army overseas in World War I. He died in uniform but with the assurance that the first of his apparatuses had been sent overseas. Two later famous roentgenologists, Mihran Krikor Kassabian (1870–1910) and William Carl Egelhoff (1872–1907), first came in contact with roentgen rays when serving as members of the Army Hospital Corps in the Spanish American War. Both may have developed their interest in radiology while serving with the Army.

Fielding H. Garrison:[3] Arthur Carlisle Christie, another well-known Army radiologist, learned this specialty as a Medical Corps officer in the Regular Army. He resigned in 1916 but returned to active duty in World War I. He was placed in charge of the Division of Roentgenology. Of the value of the roentgenologic training received in the Army Schools he said, "Very many men who knew nothing at all of the value of x-ray work before the war, came back after the war, and appreciated the value of this work."

Arthur C. Christie:[4] In addition to the military roentgenologists who gave so much to this specialty, the Army has also pioneered in equipment and training. The equipment in the Spanish American War was meager though effective. It consisted of 17 units, 12 of which were coil-apparatuses and 5 static machines.

Before the entrance of the United States in World War I, plans had been made to insure an adequate number of men and supplies in roentgenology. At the call of the Council of National Defense, The American Roentgen Ray Society's Committee of Preparedness and the Surgeon General's Office met. Some of the results of this collaboration were the establishment of special training schools in nine cities in the country and immediate investigation into the possibilities of devising new equipment to meet the demands of war.

Percy M. Ashburn:[5] Prior to the war only the larger of the military hospitals had roentgenologic equipment which was furnished by the Supply Division. However, the use of the roentgen ray in diagnosis was so thoroughly established that it was arranged to equip all hospitals with it. A separate Division of Roentgenology was established with Col. Arthur C. Christie, MC, in charge.

The duties of the section were to train and furnish expert personnel to standardize equipment and to advise on the purchase of material by the Supply Department. To secure sufficient trained personnel, training courses were established in cities, and, later, in the military training camps and the Army Medical School. Hundreds of officers and technicians were trained. The radiologic service was very satisfactory and useful. War training in, and use of, roentgenology greatly extended its use, in the Army and out, after the war. Apparatus was examined and tested in New York and Washington. Factories were inspected and their capacities known before contracts were let. A standard table was designed and adopted, as well as a satisfactory portable

[2] Middleditch, Livingston, Jr. A description of the Caldwell stereofluoroscope. Am. J. Roentgenol., 1918, *5*, 547–553.

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apparatus. By the time of the armistice there had been shipped abroad 719 sets of radiologic apparatus.

I will not attempt to discuss the many thousands who made contributions during World War II, as time prohibits, and it has been said many times that history should not be discussed in the presence of those who made the history. However, I am sure that you would all like to join me this morning in saluting a wonderful friend, fine gentleman, comrade and soldier—Dr. Byrl R. Kirklin. I am sure he is reaping his just rewards. These men, and thousands of others, have given us a great heritage. We have gone a long way in radiology. Just how far have we gone?

I would like at this time to read for you an extract from the Report of The Surgeon General, Army, dated 1897–1898.

Capt. W. B. Banister, Assistant Surgeon, Fort Crock, Nebraska, forwarded reports of a traumatism caused by exposure to the roentgen ray. The case is interesting because of the duration of the exposure and the extent of the resulting lesion. The first report is dated October 15, 1896, and describes the condition of the patient about a month after the "burn" was inflicted. The second or supplementary report was forwarded nearly six months later, April 6, 1897.

Capt. Banister's Report: *Captain W. was accidentally shot in the lumbar region to the right of the spinal column, the ball grooving the crest of the ilium. It ranged upward and inward and lodged probably in the neighborhood of the spinal column. Immediate paralysis from the waist down resulted. There was slight sensation in the left foot within an hour or two after the injury, and the patient was able to lift that foot within two or three weeks. In three weeks he began to have acute pain in the right leg, but could not move it, and was confined to bed for eleven weeks. At the end of a year he could walk with the aid of a cane, and there has been steady improvement ever since. About sixteen months after the injury, the use of the left leg was not impaired, but there was some atrophy of the right thigh with paresis of the flexors supplied by the anterior crural nerve. With the aid of a cane he could walk fairly well and had difficulty only in ascending steps. The bullet presumably plowed its way through the dense lumbar fascia and muscles until arrested in its course by the spinal column, and its impact caused sufficient hemorrhage either in the cord or its membranes to temporarily interfere with the functions of the nerves given off below the point of compression. The case had been improving steadily for a year, and there was, therefore, no good surgical reason for attempting the removal of the bullet. While in Chicago he had three exposures to the "X-rays" of one and a half hours each, making four and a half hours in all that the tissues of the skin were subjected to their action. As far as locating the bullet was concerned, the result was negative. Some redness of the skin resulted, but not sufficient to cause any inconvenience. We may conclude, therefore, that integument can stand an exposure of four hours, divided between two successive days, without material damage. Later the patient underwent further exposures, which were as follows:*

Date	*No. of Exposures*	*Average Length of Each*	*Total Exposures*
		Hours	*Hours*
September 9	*3*	*1½*	*4½*
September 10	*2*	*1⅓*	*2⅔*
September 11	*2*	*1½*	*3*
September 12	*1*	*1⅔*	*1⅔*
Total			*11⅚*
Previously administered			*4½*
			16.20

There was no result so far as locating the bullet was concerned, but there were other results that left the patient a sadder and wiser man. The skin began to show the action of the X-rays and the inflammation extended each day during the exposure. The vacuum tube, during the exposure, was held a little below and to the right of the umbilicus. In that situation the epidermis had been destroyed for a space of about one-half the size of a man's hand exposing the red inflamed and hyperesthetic cutis vera, from which the outpouring of serum was very profuse. A red blush extended from the center in every direction but principally to the right of the median line and from below upward. The death of the epidermis rapidly extended and large blisters formed beneath it such as occur in scalds. In a few days the denuded surface measured 8 by 15 inches, rec-

tangular in shape, the largest diameter being from above downward. The superficial layer of the cutis vera was thrown off, leaving a raw, bleeding surface, and the quantity of serum (with some pus) that exudes is astonishing. The lesion extends upon the thorax to the level of the right nipple. The patient has been confined to the bed for a month and the denuded surface is so hyperesthetic that he could not stand the application of the gauze and absorbent cotton dressing, and it was necessary to cover the surface with perforated gutta-percha tissue. No drying or astringent powders seem to have any effect in checking the outpour of serum, which is quite an annoyance to the patient. His beard is naturally dark brown in color, but since the prolonged exposure to the X-rays no beard at all has grown on the chin where formerly a goatee flourished, and the rest of the beard on the right side which was in the line of the ray has turned white or light yellow. The integument of the chin was reddened, but the epidermis was not destroyed. During the exposure the patient sat with the right hand grasping the rounded end of the arm of a chair. It can readily be seen by trial that if one grasps with the right hand the arm of a chair in a natural pose, that the dorsal surface of the fingers turn outward and forward while the dorsal surface of the last phalanx of the thumb turns forward and inward, and in that position would be impinged upon by the X-rays at a right angle; at least that is the only explanation of the fact that the integument over the dorsal aspect of the last phalanx of the thumb was reddened, and it seems quite likely that the nail will be lost. It would seem that the rays impinging upon the tegumentary surface at very acute angles produce no irritating effect, for the curved lateral aspect of the abdomen which must have been impinged upon by the rays showed no sign of irritation, while the thumb, which was further removed from the focus of irritation, was affected.

The intensity of the irritation seemed to be in proportion to the approximation to a right angle at which the rays impinged upon the tegumentary surface. In that respect the roentgen rays seem to resemble heat rays. As the X-rays pass through the body, it is strange that no irritating effect is produced upon the peritoneum, a much more delicate membrane than the skin. This fact would lead me to believe that the inflammation of the skin resulting from the X-ray is due to the action of the X-ray on the terminal nerve filaments in the skin, probably the vaso-motor nerves, as the structure that receives the full intensity of the rays is the only one affected. It is therefore a change in the nutrition of the tissues. The patient wore a lightweight undershirt during the exposures and felt no heat or pain during the passage of the rays through the skin. This absence of apparent effect might in itself be a source of danger in using the X-rays about the face, as it can readily be seen that it might so seriously inflame the delicate conjunctiva as to even imperil the integrity of the cornea. Again, it might cause the permanent loss of eyebrows and eyelashes and thus disfigure the patient. On the other hand, the X-ray might with great advantage be used to remove hairy growths for a cosmetic effect, and with a good prospect of the hair not returning. (Capt. Banister was a very astute man.)

Supplementary Report: *In the report on a lesion resulting from the use of the X-ray in the case of Captain W., written October 15, 1896, some erroneous conclusions were reached which further observation of the case enables me to correct. My excuse for submitting a further report on this case, covering a period of six months and up to the time the patient passed from under my observation, is my desire to place on record a case of X-ray burn which has no parallel in medical literature up to date, either in the length of exposure (sixteen hours, twenty minutes) or in the extent (15 by 8 inches) and intensity of the resulting lesion. It must prove of interest as illustrative of the effect of the X-ray when pushed to extremes, as no exposures of such length will probably occur again. In a recent letter from a surgeon in charge of an X-ray laboratory in Chicago, he informed me that they made exposures now of only ten minutes' duration. In my first report I made the prognosis that the lesion would heal in two months, a prognosis based on similar lesions, such as superficial burns, etc. In this opinion I was in error, as further experience demonstrated to me that there are no similar lesions, and any prognosis based on apparently similar precedents would necessarily be erroneous. At the end of six months the lesion has not healed, though the original extent has been reduced from 15 by 8 inches to 8½ by 3 inches, and it will yet be many months before the patient will be cured. The beard, which I reported as having fallen out and showing no signs of returning, did return in about six weeks from date of injury, and was noticeably thicker and coarser than before. The hair on the thorax and abdomen, where healing has occurred, has not returned. The entire denuded surface was covered with a false membrane which in places was from a quarter to half an inch thick and thrown into folds. The central portion of the lesion presented an open*

ulcer involving the entire thickness of the skin down to the superficial fascia. The most distressing feature of the case is the intense pain, which nothing but morphine will control, and which seems to have no relation to the extent of the lesion, as it is as intense now as it was four months ago, when the denuded surface was much larger. The use of morphine is much to be deprecated in a case of this character, where every nutritive function and all emunctories should be at their maximum of efficiency, but the pain is unbearable, and the patient can secure no rest without it. The slowness with which this apparently superficial denudation heals is almost incredible. It must be in great part superficial, for nearly 100 square inches have healed without any cicatrix, but what remains must heal by cicatrization by reason of the depth of the ulceration. (And again I must state—Capt. Banister was a very observing, very astute man.)

From an unsuccessful exposure of sixteen hours and twenty minutes to our present day roentgenography is a long way. And so I repeat, our heritage is a great one. It has meant that we have had the privilege of prolonging the lives of thousands upon thousands, of alleviating suffering of thousands upon thousands. Yet there are some today, so ill advised, that they would take this heritage away from us. And here I must chastise you.

I think that you have been a bit negligent in your duties in protecting your heritage. I say this because during my stay here in Washington I have attended several conferences as a spectator, read of several investigations in which the biological effect of ionizing radiation was the topic of discussion. In almost every instance I noted that this subject was discussed—not by radiologists—but by others, many of whom were not even physicians. I am of the opinion that when such an important subject as this is discussed, in an atmosphere of national importance, radiologists should certainly take an active part. I am sure that you are taking a more aggressive position in this matter at the present time, so I feel nothing more need be said.

It is now my pleasure to inform you that The Surgeon General of the United States Army has assembled an Advisory Editorial Board on the History of Radiology in World War II. We have as Chairman of this Board Kenneth D. A. Allen, M.D., who has done so much for radiology in the past and, I am sure, will continue to do so in the future. Other members of the Board consist of myself, Col. Alfred A. deLorimier, MC, USA (Ret), who has made so many fine contributions to radiology, Col. John A. Isherwood, MC, dean of radiologists in the Army, Philip J. Hodes, M.D., University of Pennsylvania, Charles W. Reavis, Chattanooga, Tennessee, and Col. J. B. Coates, MC, ex officio.

We are all very pleased that the History of Radiology will be written. Unfortunately, this was not done following World War I. I hope by the time of your next annual meeting, or perhaps the meeting following, that the volume on Radiology in World War II will have taken its place beside other volumes on Surgery, Orthopedic Surgery, Cold Injuries, etc.

Again, it has been a great pleasure to welcome you and, as we old Southerners say, "It was so nice of you to come—you all hurry back and see us." God bless you.

FIFTY-NINTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Fifty-ninth Annual Meeting of the American Roentgen Ray Society was held at the Shoreham Hotel, Washington, D. C., September 29 through October 3, 1958.

From the Preliminary Program that was published in the July issue of the JOURNAL, one could sense that the forthcoming meeting would be an excellent one. The Meeting exceeded all expectations, not only for the caliber of the Scientific Program itself, but also for the display of Scientific Exhibits, which equaled or were superior to any previous exhibits held at any of the Annual Meetings. The Technical Exhibits, too, have never been surpassed.

The Program was arranged by President-Elect Barton R. Young and his Committee who were responsible for the striking success of the entire Meeting.

The Scientific Session was formally opened on Tuesday morning with a call to order by President Wendell G. Scott. The Address of Welcome to the Society was given by Major General James P. Cooney, Deputy Surgeon General, Department of the United States Army. This address is published in full immediately preceding this account of the meeting.

Following the Address of Welcome, President-Elect Barton R. Young, was installed as President of the Society. Doctor Young was inducted into office by President Wendell G. Scott and Doctor Wilbur Bailey, Chairman of the Executive Council. Doctor Young in his Inaugural Address *The American Roentgen Ray Society: Its Previous, Present-Day and Future Importance to Radiology and Medicine* portrayed in a most vivid manner the unique role of the American Roentgen Ray Society in the history of Radiology and its contribution to Medicine in general. This splendid address is published as the leading article in this issue of the JOURNAL.

President Young and his Program Committee departed somewhat in arranging the program of this year's Annual Meeting in that they scheduled two feature lectures. The first of these was delivered by Doctor Robert R. Newell following the Presidential Address. The second feature lecture was given by Doctor Ernest E. Aegerter, Professor of Pathology, Temple University, Philadelphia, on Thursday morning.

Doctor Newell discussed an aptly timed subject of extreme interest and import to all radiologists. It was entitled *Common-Sense Evaluation of Radiation Exposure in Clinical Radiology*. With Doctor Newell's excellent background for such a subject, he gave a most informative presentation on a problem which is ever present in radiologic practice. The lecture is published in this issue of the JOURNAL and all of those who are concerned about radiation protection, and all should be, would profit considerably by reading Doctor Newell's sound philosophy and thoughtful advice.

Other papers followed dealing with radiation hazards—one of which was *Radiation and the Community: A New Role for the Radiologist* by Doctor George Tievsky. In his paper Dr. Tievsky presented a practical plan for the development of a radiation control program which he said may be divided into several areas. Such a program should first ascertain the existing pattern of radiation protective measures being employed by the radiologist of the area. Among other things he emphasized the fact that "Unless leadership is shown by radiologists at a local level, it may come from sources which may put us (radiologists) into a markedly subordinate position," and he explained in detail how this situation might be avoided.

Another important paper of the morning was given by Doctor Howard B. Latourette and Doctor Fred J. Hodges on the *Incidence of Neoplasia after Irradiation of Thymic Region*. They reported on a series of over

800 patients, mostly infants, who had been irradiated at the University Hospital in Ann Arbor from 1932 through 1940 for what was considered to be "thymic enlargement." They discussed in detail this group of patients and the follow-up in over 87 per cent of them in an attempt to ascertain the incidence of lymphoblastoma. Their results were most informative. They called attention to the fact that no patient in their group was known to have developed carcinoma of the thyroid gland.

A very imposing group of papers having to do with angiographic studies followed. The first of these entitled *The Angiographic Study of Carotid Insufficiency and Cerebral Ischemia* was given by Doctor Marvin M. Keirns and Doctor John E. Whiteleather, Memphis, Tennessee. This was a very instructive study on one of the most difficult problems we have to deal with in medicine today. The second paper entitled *Radiologic Aspects of Cerebral Angiography in Children* was given by Doctor Juan M. Taveras and Doctor Charles M. Poser of New York City, and the third paper which comprised a discussion on *Roentgenographic Demonstration of the Tentorial Incisura: Signs of Cerebral Herniation through This Notch in Vertebral Angiograms* was presented by Doctor H. F. Plaut of Dayton, Ohio.

Among the papers on Tuesday morning was *Roentgenologic Manifestations of Glioma of the Optic Nerve and Chiasm.* This presentation by Doctor Colin B. Holman of Rochester, Minnesota proved most enlightening. A paper dealing with *Roentgenological Features of Meningeal Fibroblastoma* by Doctor Sidney P. Traub of Saskatoon, Canada, illustrated by numerous examples what may be learned from careful studies of the roentgenograms of the skull without additional specialized studies dealing with intracranial lesions.

On Tuesday evening the Caldwell Lecture was delivered by Doctor Leo G. Rigler, Consultant in Radiology, Cedars of Lebanon Hospital; Visiting Professor of Radiology, University of California at Los Angeles; President, Radiological Society of North America. Doctor Rigler was introduced by Doctor Harold O. Peterson, Professor of Radiology, University of Minnesota, Minneapolis. Doctor Peterson gave a most entertaining and informative introduction of Doctor Rigler and his accomplishments in the field of radiology and medicine. Doctor Rigler, who speaks with greatest authority on diseases of the lungs and their radiologic manifestations, chose as his subject *Functional Roentgen Diagnosis: Anatomical Image—Physiologic Interpretation.* He brought out many pertinent points in discussing the various pulmonary processes and stressed the importance of proper evaluation of the normal and abnormal physiologic manifestations in the analysis of the roentgenograms of the lungs.

Upon the completion of Doctor Rigler's excellent address, President Young, with most appropriate and well chosen phrases, congratulated Doctor Rigler on his eminent work in medicine and radiology, and presented to him the Caldwell Medal—one of the highest honors which is conferred by the American Roentgen Ray Society.

On Wednesday morning, the Scientific Program continued with Doctor Eugene P. Pendergrass presiding. The first paper was given by Doctor Harold N. Margolin and his associates on *Idiopathic Unilateral Hyperlucency of the Lung: A Roentgenologic Syndrome.* This paper was of great value to all radiologists, since one has occasion to observe in his daily work abnormal radiolucencies of the lobe of a lung, which may be caused by a variety of conditions. Doctor Margolin and his associates discussed such conditions as might bring about these changes and their roentgenographic manifestations.

The next paper was a presentation on *Body Section Roentgenography in the Evaluation and Differentiation of Chronic Hypertrophic Emphysema and Asthma* by Doctor Robert G. Fraser and Doctor David V. Bates, Montreal, Canada. These authors showed a number of comparative cases as a foundation for their discussion of the

place of body section roentgenography in the evaluation of these diseases. They called attention to the importance of this method because of the technical simplicity of the examination, and they believe that such an additional study may find much practical application, particularly in those centers were detailed physiologic pulmonary studies are not readily available.

A paper entitled *The Importance of Chest Roentgenography in the Diagnosis of Pulmonary Embolism* was given by Doctor George N. Stein and his associates from Philadelphia, Pennsylvania. Doctor Stein called special attention to the fact that the radiologist has a key role in the diagnosis of pulmonary embolism since there are no pathognomonic clinical or laboratory findings present. It is important, he pointed out, that the radiologist be familiar with the varied manifestations of this disease. He also stated that from 1955 to 1957, pulmonary embolism was the most common disorder encountered in the lungs at the Graduate Hospital in Philadelphia. The paper was not only timely but instructive and gave in considerable detail the pitfalls in the diagnosis of this often seen clinical picture.

Doctor B. Skinner and his associates from Montreal, Canada, discussed the *Investigation of the Effects of Opaque Media on the Lungs, with Comparison of Barium Sulphate, Lipiodol and Dionosil.* The paper was of particular interest because of the constant search for the proper opaque media for contrast studies in roentgenography.

Doctor C. Allen Good and his associates, Rochester, Minnesota, gave an excellent paper dealing with diseases of the chest, entitled *Positive Roentgenograms Plus Positive Sputum Smears Do Not Always Equal Pulmonary Tuberculosis.* This paper is of great importance, and upon its publication should be read by all radiologists and those interested in chest diseases.

The group of papers dealing with diseases of the lungs was followed by equally valuable papers on other timely diagnostic subjects.

Doctor J. Stauffer Lehman and his associates from Philadelphia gave a comprehensive discussion on *Coronary Arteriography* in which they stressed the increasing clinical importance of reliable means of assessing the coronary arterial system. Needless to say, this is one of the most frequently encountered conditions in medical practice at the moment, and any studies which might provide additional knowledge on this subject are always welcomed.

Doctor D. E. Boblitt and Doctor Melvin M. Figley of Ann Arbor, Michigan, and Seattle, Washington, gave an interesting paper on *Contrast Material Dissection of Aortic Wall in Direct Aortography.* This paper called attention to some of the potential hazards in the use of contrast material in the examination of the aorta.

Doctor George T. Wohl and Doctor Leah Shore of Philadelphia, Pennsylvania, chose as their topic *Lesions of the Cardiac End of the Stomach Simulating Carcinoma.* The great clinician, William Osler, referred to the right upper quadrant as the area of "diagnostic romance." This was before the days of radiology. By a somewhat similar application, one might use the same phrase in a discussion of the lesions of the cardiac end of the stomach—one of the most difficult areas for proper study and interpretation in the gastrointestinal tract. Doctor Wohl and Doctor Shore presented numerous examples of the errors that might be found, and they also indicated the most useful type of examination for so important an area.

An outstanding paper was presented on *The Value of Delayed Gastric Emptying Roentgen Study of the Abdomen in the Detection of Ulcer, Carcinoma and Other Organic Disease of the Upper Alimentary Tract* by Doctors Jay W. MacMoran, Robert B. Funch and Barton R. Young, Philadelphia, Pennsylvania. In the course of their discussion, these authors advocated the use of

a one-hour film of the abdomen following examination of the stomach in the hope that lesions which might have been missed in the initial examination would be discovered in the films exhibiting delayed gastric emptying.

In the following paper Doctor Bertram R. Girdany and his associates from Pittsburgh dealt with *Radiologic Aspects of Hydrostatic Reduction of Ileo-Colic Intussusception*. In this paper, apart from a discussion of the great diagnostic possibilities, it was brought out that hydrostatic reduction of intussusception can be almost uniformly successful in the absence of gangrene.

Another well presented paper on Wednesday morning was one given by Doctor David Kirsh and Doctor Rudolph E. Drosd of Miami, Florida, who discussed *Roentgen Abnormalities in Disease of the Appendices Epiploicae*. This paper called attention to a pathologic condition which too frequently goes unrecognized.

Thursday morning the Scientific Session continued with Doctor John P. Medelman presiding. The first item on the program was the second feature lecture by Doctor Ernest E. Aegerter of Philadelphia who dealt with *What Every Radiologist Should Know about Bone Tumors*. Those who were privileged to sit in the audience and witness the graphic presentation of this subject will long remember the experience. The lecture contained a wealth of material presented in a most engaging manner by Doctor Aegerter and those associated with him. Emphasis was placed on the classification of "bone tumors," breaking them down into reactive processes in bone, hamartomas of bone and true bone tumors. Dr. Aegerter described the characteristic age and site incidence of each entity and discussed the other peculiarities of symptomatology, roentgenographic appearance and behavior, "which it is believed should aid the radiologist in diagnosis."

Following this, Doctor Robert H. Freiberger and his associates from New York City discussed *Osteoid Osteoma. A Review of 80 Cases*. The characteristic roentgen findings and technique of examination of such lesions were presented. Gross and microscopic features and differential diagnosis by histologic and roentgen findings were discussed.

An experimental paper dealing with *Radiation Induced Dysplasias of Bone. Concepts in Bone Modeling* was given by Doctor Philip Rubin and his associates of Rochester, New York and Bethesda, Maryland. This paper was concerned with research designed to induce modifications of either cartilage growth, chondroclasis, osteogenesis, or bone absorption by ionizing irradiation, in the hope that such studies might contribute to the understanding of the dynamics of bone modeling.

Doctors Roderick L. Tondreau, Philip J. Hodes and Erwin R. Schmidt, Jr., of Philadelphia, gave an excellent paper on *Joint Infections following Steroid Therapy: Roentgen Manifestations*. They observed a number of cases of septic and tuberculous arthritis following intra-articular injections of hydrocortisone. The roentgen manifestations in the affected joints were described.

Doctor Ted F. Leigh and his associates from Emory University, Georgia, selected as their topic *Myelofibrosis: The Radiologic Findings in Twenty-Five Proven Cases*. They discussed the salient clinical features, including the methods of diagnosis, the histologic picture, and the current measures of treatment of this particular condition.

The Visual Physiology of Roentgen Diagnosis: A Technique for the Evaluation of Roentgen Methods was the title of a presentation by Doctor William J. Tuddenham of Philadelphia. He pointed out that the accuracy of roentgen diagnosis may be increased through more precise control of image contrast and proper development of selective roentgenographic techniques, together with control of the "film reader's" environment. His paper was an interesting discussion of a subject which should be

close to the heart of all radiologists.

Doctor J. Luther Jarvis and Doctor William B. Seaman of New York City discussed *Idiopathic Adrenal Calification in Infants and Children*. Their material was based on 22 cases of idiopathic adrenal calcifications discovered as incidental findings on roentgenograms and/or autopsy. The pertinent features were reviewed in this rather rare condition.

This paper was followed by one given by Doctor Harold Fulton, Doctor James J. Snider and Doctor Lawrence Reynolds, Detroit, Michigan, on the *Roentgenographic Analysis of Renal Mass Lesions (Cysts and Tumors)*. In this paper it was brought out that the application of certain roentgen diagnostic criteria in renal mass lesions (carcinoma and simple cysts) might permit a more accurate diagnosis than was previously thought possible. The clinical history, laboratory findings, and pyelographic patterns were objectively recorded in an attempt to correlate these features with the pathologic findings following surgical exploration. The results of this analysis were presented with illustrated case reports.

Doctor Nathan Poker and his associates of New York City discussed *The Radioisotope Renogram: An Objective Method of Analysis*. These authors investigated the renal vascular bed in normal and diseased kidneys by means of an external gamma-ray scintillation counting technique, which tests the function of each kidney separately. From their observation they concluded that this type of study allows a more detailed analysis of the vascular phase of each kidney than has heretofore been available.

Doctor Barbara L. Carter and her associates from Philadelphia, Pennsylvania concluded the Thursday morning Scientific Session with an instructive paper on *A Critical Evaluation of External Body Surface Counting in the Determination of Cardiac Output with Radioactive Isotopes* which was most interesting.

On Thursday evening cocktails were served in the Lower Lobby preceding the Banquet which was held in the Terrace Room of the Shoreham Hotel. As is customary at the Banquet, the newly elected officers were introduced to the members of the Society and their guests. The awards bestowed for the most meritorious scientific exhibits were also presented. The Banquet which was very well attended proved to be a most delightful and festive occasion. A floor show with an excellent program and an opportunity for dancing added to the gaiety and enjoyment of the evening.

Friday morning the Scientific Session continued with Doctor John E. Whiteleather presiding. The undiminished interest, evidenced by the large attendances on the previous days, was also noted at this morning's session, which was devoted in the greatest part to topics dealing with various forms of radiation therapy.

The Session began with a discussion on *The Physical Aspects of a Cesium Teletherapy Source* by Charles S. Simons, Ph.D., Doctor Isadore Lampe and Doctor Howard B. Latourette, Ann Arbor, Michigan. A cesium-barium 137 source of approximately 2,000 curies has been made available at the University of Michigan and the various physical aspects of the new unit as a possible agent of radiation therapy were discussed. Isodose curves for a number of typical fields were shown and compared with those of cobalt used in a similar teletherapy device. The authors pointed out that the clinical application of cesium radiation has been too limited to permit satisfactory evaluation.

This paper was followed by one given by Doctor Halvor Vermund of Madison, Wisconsin, on *The Significance of the Tumor Bed Reactions in the Radiation Treatment of Malignant Tumors*.

A paper presented by Lucille A. DuSault, Doctor William R. Eyler and Doctor Glen D. Dobben of Detroit, Michigan, was entitled *The Combination of Oxygen and Optimal Fractionation in Radiation Therapy of Adenocarcinoma*. This paper dealt with some of the results obtained with and without oxygen in fractionated irradiation of spontaneous mammary adenocarcinoma in C_3H mice.

Doctor G. J. D'Angio and his associates

from Boston, Massachusetts, discussed *The Radio-therapeutic Management of Certain Complications of Acute Leukemia in Childhood.* Radiation therapy has proved to be of value in controlling certain symptoms and signs in acute leukemia in childhood, and the technique of radiation therapy which the authors have employed in certain treatments was presented.

Doctor James C. Cook and Doctor K. L. Krabbenhoft, Detroit, Michigan, read a paper on *Hodgkin's Disease: Combined Roentgen and Nitrogen Mustard Therapy As Compared to Roentgen Therapy Alone.* A series of 392 cases of Hodgkin's disease treated during the period of 1923 through 1957 was reviewed. Of these the majority treated during the last ten years received combined roentgen and nitrogen mustard therapy. In the discussion they pointed out that a definite improvement was observed statistically in the group treated by the combined method.

Carcinoma of the Tonsillar Area: Factors Influencing the Results of Treatment was the title of the paper given by Doctor Norah duV. Tapley, Doctor Robert A. Evans, Doctor Morton M. Kligerman and Doctor Harold W. Jacox, New York City. These authors discussed the possibility of determining radiation sensitivity by cytologic methods and thereby more appropriately selecting the cases for intensive irradiation or surgery. They also analyzed the five-year survival group in an effort to determine any common factors that could be correlated with the results of successful therapy.

Doctor Robert D. Moseley, Jr., and his associates from Chicago, Illinois, discussed *Trans-Sphenoidal Destruction of the Hypophysis with Radioactive Yttrium.* Their presentation was based upon the well established fact that many cancers arising in the breast and prostate gland are subject to endocrine influence. Formerly in such cases hypophysectomy was performed as an extension of the hormonal modulation approach to cancer therapy. They described a technique which they have developed for destruction of the hypophysis by implanting the gland with pellets of Y^{90}.

Doctor J. Robert Andrews and his associates, Bethesda, Maryland, and Rochester, New York, spoke on *The Effects of One Curie of Sulfur*^{35} *Administered Intravenously As Sulfate to a Man with Advanced Chondrosarcoma.* The pattern of the elimination of the sulfur and the distribution of the portion retained had been studied and the immediate and late radiation effects were reported and related to the dosimetric considerations and possible therapeutic effects developed by the study.

An experimental paper dealing with *Radiographic Visualization of Lymph Nodes and Lymphatic Channels* was given by Doctor Harry W. Fischer and Doctor George R. Zimmerman of Iowa City, Iowa.

The last paper on Friday morning was that of Doctor John L. McClenahan of Philadelphia, on *The Joy and Cost of Office Radiology.* Doctor McClenahan gave a summary of one man's recent experience in establishing an office on the East Coast for the practice of Radiology. It was a delightful, interesting paper given in an engaging manner.

The Instructional Courses, which were instituted in 1939 and have proved to be one of the important features of the Annual Meetings of the American Roentgen Ray Society, were again given this year under the directorship of Doctor Harold O. Peterson. Doctor Peterson had surrounded himself with a distinguished group of instructors which added to the popularity of the various courses.

An innovation this year was the meeting of those whose interests and activities lie in Pediatric Radiology. This group held its inaugural conference on Monday, September 29, 9:00 A.M. to 5:00 P.M. and on this occasion laid the foundation for the Society of Pediatric Radiology.

Adequate time had been allotted for viewing the Scientific and Commercial Exhibits. The Scientific Exhibits this year were collected under the Chairmanship of Doctor Cesare Gianturco, and his committee included Doctor Ted F. Leigh and Doctor Richard H. Marshak. As already stated in

the introductory remarks, they all were of excellent caliber. The Technical Exhibits, likewise, were outstanding in quality and character, and attracted much attention and the highest praise. Needless to say, both added immeasurably to the success of the meeting.

Elsewhere in the JOURNAL are accounts of the Scientific Exhibits and of the Commercial Exhibits, together with a list of the exhibitors.

While the Scientific Sessions, Instructional Courses and the Scientific and Technical Exhibits are of prime importance, there are also social amenities which are observed at all of the Annual Meetings. The Society is grateful to the Committee on Local Arrangements under the able Chairmanship of Doctor Edgar M. McPeak for the splendid and carefully arranged social activities which highlighted this year's meeting. For the visiting ladies an excellent program was prepared by the Local Committee under the chairmanship of Mrs. Edgar M. McPeak. This included a Golf Widows' dinner, a luncheon and various trips throughout Washington. The Society is also grateful to Mrs. McPeak's Committee and to all those who participated in the arrangement of this program for the manner in which it was executed.

As is customary on the Monday preceding the meeting, the Annual Golf Tournament for members and guests was held at the Manor Country Club, Norbeck, Maryland, for the Willis F. Manges Trophy and the Exhibitors' Trophy. This was followed by the Annual Golf Dinner at the same Club.

To the Washington Convention Bureau the members of the Society express their appreciation for the competent manner in which the registration was handled.

To the Management and Staff of the Shoreham Hotel the Society extends its sincerest thanks for the arrangments which were made for the meeting, the success of which in no small part was due to their cooperation.

To the Committee on Press Relations under the Chairmanship of Doctor Alvin C. Wyman, with the assistance of Doctors Eugene McDonald and Isidore Lattman and with the splendid aid and excellent judgment of Mr. Hugh Jones of the American College of Radiology, the Society expresses its profound appreciation for the fine job which was well carried out.

From the favorable comments which one heard on all sides, both during and after the meeting, it is the concerted opinion that the Fifty-ninth Annual Meeting of the American Roentgen Ray Society was an excellent one in all respects and one that will be long remembered by those who were privileged to attend.

THE SCIENTIFIC EXHIBITS

The Scientific Exhibits of the Fifty-ninth Annual Meeting of the American Roentgen Ray Society held at the Shoreham Hotel, Washington, D.C., September 30 to October 3, 1958 undoubtedly were of the highest standard and reflected in a splendid manner the amazing progress which is continually being made in the domain of scientific radiology. President-Elect Barton R. Young and the Scientific Exhibits Committee under the able Chairmanship of Dr. Cesare Gianturco have spared neither time nor effort in an attempt to secure the most outstanding contributions of present-day interest and made all the necessary arrangements for their most successful display. The West Ball Room, just off the main foyer, was chosen to house the exhibits because of its proximity to the main auditorium, where the Scientific Sessions were held. The unusually great attention which they attracted, besides being an ample reward for President-Elect Young and Dr. Gianturco and his Committee, had markedly contributed to the over-all success of the Annual Meeting. A further evidence of the excellence of this year's Scientific Exhibits is attested to by the fact that the Awards Committee after four years has again awarded the Gold Medal. In addition, the Silver and Bronze Medals, and ten Certificates of Merit were bestowed as tokens of special recognition.

The following is the list of the awards.

I. GOLD MEDAL. *Coronary Arteriography*. J. Stauffer Lehman, M.D., Randal A. Boyer, M.D., and Fred S. Winter, M.D., The Hahnemann Medical College and Hospital of Philadelphia, Philadelphia, Pennsylvania.

The desirability of reliably assessing the coronary arterial system by various procedures is of increasing clinical importance. This exhibit presented three roentgenologic procedures employed for the opacification of the coronary arteries, reviewed the histories and techniques of each of these procedures, and gave comparative figures of the type of opacification obtained. The three procedures were: (*A*) catheter thoracic aortography—attempted 44 times in 44 patients, with 4 failures; (*B*) cardiac ventriculography—attempted 230 times in 199 patients, with 28 failures; and (*C*) suprasternal thoracic aortography—attempted 107 times in 90 patients, with 30 failures. An additional group (*D*) included cases of cardiac arrest coronary arteriography, which was induced by acetylcholine. This procedure, after extensive experiments on dogs, was attempted 22 times in 22 patients, with 1 failure (para-aortic injection).

The type of opacification was graded: (a) excellent, (b) good, (c) fair, (d) poor, and (e) no visualization. With procedure (*A*) there was excellent visualization of both coronary arteries in 10 per cent and no visualization of either coronary artery in 25 per cent. With the three other procedures the respective figures were: (*B*) 7 and 9 per cent; (*C*) 12 and 12 per cent; and (*D*) 24 and 0 per cent.

Coronary arteriograms demonstrating both normal and disease states of the coronary arterial system in humans and the experimental opacification in dogs were shown. The effect of temporarily induced cardiac arrest in improving the type of opacification was illustrated.

II. SILVER MEDAL. *Pulmonary Alveolar Proteinosis—a New Entity*. Samuel H. Rosen, M.D., Benjamin Castleman, M.D., and Averill A. Liebow, M.D., with the collaboration of Frank M. Enzinger, M.D., Richard T. N. Hunt, M.D., and Col. William L. Thompson, MC, USA, Armed Forces Institute of Pathology, Massachusetts General Hospital and Yale University School of Medicine, Washington, D. C., Boston, Massachusetts and New Haven, Connecticut.

This exhibit presented a new disease entity of the lungs of unknown etiology.

The following are its characteristic features: (1) the accumulation of a granular,

periodic acid-Schiff (PAS) positive proteinaceous material, rich in lipids in the alveoli, usually with little or no inflammatory reaction; (2) a chronic but variable clinical course in which both improvement and fatal termination have been observed; (3) a relatively mild symptomatology, not in proportion to the usually extensive roentgenographic evidence of pulmonary involvement, with dyspnea and cough as the main symptoms, few or no physical signs and no contributory laboratory findings; (4) a roentgenographic appearance often simulating that of pulmonary edema, but persisting for months or years, during which the changes may clear, remain more or less stationary, or progress.

Roentgenograms, photographs of gross specimens and photomicrographs were presented, amply documenting the pertinent findings. The material on which the study was based consisted of 27 cases, 26 of which were observed during the past three years and 1 almost five years ago.

III. Bronze Medal. *Radiation Induced Dysplasias of Bone—Concepts in Bone Modeling.* Philip Rubin, M.D., J. Robert Andrews, M.D., Richard L. Swarm, M.D., and Lucy Squire, M.D., University of Rochester (National Institutes of Health), Rochester, New York.

It has long been known that as long bones grow, there are areas of physiologic destruction occurring simultaneously; *i.e.*, a shaping or modeling process is acting as new bone is formed at the ends of shafts to maintain the typical tubular appearance of the diaphysis. Studies designed to induce modifications of either cartilage growth, chondroclasis, osteogenesis, or bone absorption by ionizing radiation may contribute to an understanding of the dynamics of bone modeling.

Numerous experiments in animals were performed to induce various dysplasias in long bones and to observe the effects in a correlated roentgenographic-histopathologic manner. This was successfully accomplished by selectively irradiating areas in bone.

This exhibit illustrated the clinical implications of these radiobiologic studies in enhancing our concepts of both normal and abnormal cartilage development, bone growth, particularly "bone modeling."

Certificates of Merit

1. *The Immediate and Late Radiation Effects of One Curie of S^{35} Administered Internally to a Case of Chondrosarcoma.* J. Robert Andrews, M.D., D.Sc. (Med.), Richard L. Swarm, M.D., and Lawrence Schlachter, M.D., National Cancer Institute, Bethesda, Maryland. The immediate hematologic and other tissue effects and the possible delayed effects on tumor were studied in a case of chondrosarcoma following the internal administration of a dose of 1 curie of radioactive sulfur (S^{35}), given in three increments over a period of twenty-one days. Quantitative determinations of the distribution of S^{35} were made over periods of days and weeks. The pattern of the elimination of S^{35} has also been studied and certain dosimetric considerations have been developed. A detailed account of the hematologic response was given and the findings and conclusions were supported by radioautographs.

2. *Contrast Material Dissection of Aortic Wall in Direct Aortography.* D. E. Boblitt, M.D., University Hospital, Ann Arbor, Michigan. With the exception of a fatal anaphylactoid reaction, intramural dissection of contrast material, producing the same pathologic effects as a spontaneous dissecting aneurysm of the abdominal aorta is the most serious complication of percutaneous lumbar aortography. Three cases were illustrated in which death had occurred following such inadvertent injections. This complication is often unrecognized because fortunately the dissection in most instances does not reach clinically significant size or extent. The valuable investigative procedure of aortography need not be deprecated or abandoned because of this potential hazard inasmuch as roentgen signs of contrast material within the aortic wall are quite characteristic and easily

recognizable. When present, they should prompt termination of the procedure and careful observation of the patient in case that a dangerous dissection has been produced by the time it is first recognized.

3. *Body Section Roentgenography in the Evaluation and Differentiation of Chronic Hypertrophic Emphysema and Asthma.* Robert G. Fraser, M.D., F.R.C.P. (C), and David V. Bates, M.D. (Cantab.), M.R.C.P. (Lond.), Royal Victoria Hospital, Montreal, Quebec, Canada. The state of the peripheral vasculature of the lungs will often serve to differentiate actual lung degeneration as found in hypertrophic emphysema from simple bronchospasm seen in asthma. This exhibit demonstrated that evaluation of the peripheral vessels by laminagraphy is a simple and accurate method of accomplishing this end.

4. *Segmental Colitis—a New Roentgen Entity.* Richard H. Marshak, M.D., Bernard S. Wolf, M.D., and Joan Eliasoph, M.D., The Mount Sinai Hospital, New York, New York. It has long been known that ulcerative colitis may involve only a part of the colon. Pathologically, this limited form of colitis is not always exudative and ulcerative, as is diffuse ulcerative colitis, but may be sclerosing and even granulomatous. The cases afflicted with this condition are baffling because there is no full agreement among pathologists as to the nature of segmental colitis. To some it is a variant of ulcerative colitis, while to others it represents regional enteritis in the colon. It has also been described as a specific disease entity and several terms used for its designation—right-sided ulcerative colitis, regional colitis, and segmental colitis.

This exhibit demonstrated that the roentgen findings in segmental colitis appear to be more specific than has hitherto been suspected. Because of the relatively good prognosis, it is of practical usefulness to attempt to make the specific diagnosis on clinical and roentgen grounds.

5. *Trans-sphenoidal Yttrium 90 Hypophysectomy.* Robert D. Moseley, Jr., M.D., William M. S. Ironside, M.D., and Paul V. Harper, M.D., The University of Chicago, Chicago, Illinois. This exhibit presented a technique for destruction of the pituitary gland by implantation of radioactive yttrium via a pernasal trans-sphenoidal approach. The following aspects of the technique were demonstrated: (1) dosimetry, including nuclear chemistry; (2) surgical procedure with fluoroscopic image amplifier control; (3) clinical response and complications; and (4) pathology of the destroyed pituitary glands.

6. *A Primer on Radiation Hazards.* Richard E. Peterson, M.D., Julius Baron, M.D., Bartis M. Kent, M.D., and Titus C. Evans, Ph.D., Veterans Administration Hospital, Iowa City, Iowa. The citizen-physician should be prepared to help maintain proper perspective in community discussions on radiation hazards. A new responsibility of physicians to evaluate medical radiation exposure effects on the individual patient's health has been pointed out. The exhibit was divided into three parts: (1) sources of radiation; (2) the human consequences (a) for the individual and (b) for the race; and (3) the search for solution.

7. *Life History of Nonspecific Ulcerative Colitis: Relation of Anatomic and Clinical Types to Prognosis.* James L. A. Roth, M.D., A. Valdes-DaPena, M.D., George N. Stein, M.D., and H. L. Bockus, M.D., Graduate Hospital, University of Pennsylvania, Philadelphia, Pennsylvania. An analysis has been made from the case histories, roentgenograms and pathologic specimens of patients treated at the Graduate Hospital for nonspecific ulcerative colitis during the years 1927–1953. This exhibit comprised a study of the relationship of various anatomic and clinical types of the disease to the life history and prognosis. The anatomic categories on the basis of topographic location included: (1) ordinary distal type, (2) regional or segmental type, and (3) enterocolitis. The cases were classified into clinical types according to the clinical course of the disease; *i.e.*, acute

fulminating, relapsing and chronic continuous types. The criteria for evaluating prognosis have been: (1) duration of attack; (2) duration of disease; (3) development of complications, colonic or systemic; (4) behavior patterns with hyperpyrexia, nutritional deficits or massive hemorrhage; (5) necessity for surgical intervention; and (6) mortality. The anatomic and clinical features were illustrated with roentgenograms and colored transparencies of photographs of the gross specimens and of photomicrographs.

The significance of "toxic megacolon" was given special attention with respect to its recognition, pathogenesis and treatment.

8. *Opacifying Biliary Calculi: The Rim Sign.* Emanuel Salzman, M.D., Robert P. Spurck, M.D., and Lawrence C. Kier, Ph.D., Denver General Hospital and the University of Colorado Medical Center, Denver, Colorado. This exhibit illustrated that some radiolucent gallstones and bile duct stones become opaque after prolonged telepaque administration both in the presence and absence of visualization of the gallbladder and bile ducts. This opacification of biliary calculi occurs in patients who have been prepared with 3 gm. of telepaque each day for four days (The Four Day Telepaque Test). A low fat diet must be observed during this interval. The opacification of the stones persists for about two weeks, gradually fading. It has been reproduced *in vitro* and about 20 per cent of all biliary calculi obtained at autopsy or surgery show this opacifying quality.

The opacification of biliary calculi after The Four Day Telepaque Test is the result of a reaction between the telepaque in the bile and a bile pigment on the surface of the stones, probably biliverdin.

9. *New Concepts in Diagnostic Roentgen Research.* William J. Tuddenham, M.D., Eugene P. Pendergrass, M.D., and John H. Harris, Jr., Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania. The perception of a critical image in a modern roentgenogram is seldom limited by its physical characteristics. It may, however, be limited by psychophysiologic factors affecting the reader and his ability to organize the visual field. Since accurate roentgen diagnosis is based upon the perception of critical shadows, it would appear that a most fruitful area for diagnostic roentgen research lies in the identification and control of these factors. Evidence in support of this hypothesis was presented together with proposed techniques for the evaluation and control of such factors.

10. *Carotid Insufficiency.* J. E. Whiteleather, M.D., and M. M. Keirns, M.D., Baptist Memorial Hospital, Memphis, Tennessee. The exhibit emphasized the need for routine inclusion of the cervical carotid artery to some distance below the bifurcation on all cerebral angiograms. Various types of occlusive disease of the carotid artery and the resulting effect on the cerebral circulation were shown. Some cases illustrated the pre- and postoperative appearance of the involved arterial segment and the improvement or restoration of the intracranial circulation. In addition, a broader demonstration of intracranial arteriosclerotic disease was presented including the general effects of ischemia on the brain.

Other Excellent Exhibits Were the Following:

Roentgenographic Time Lapse Study of Living Bone. Howard J. Barnhard, M.D., F. Dixon Conlin, M.D., John W. Lane, M.D., and Omer E. Bradsher, B.A., University of Arkansas Medical Center, Little Rock, Arkansas. Time lapse studies have long been successful for observations made of plants, or through the microscope where immobilization of the subject has not been a problem. The exhibitors have developed a mechanical means for accurately repositioning the foreleg of a dog over a period of weeks or months. During this time interval roentgenograms are made and subsequently photographed in sequence on movie film. The applications of this method appear to be in three areas: (a) as a teaching medium, (b) to detect new diagnostic signs, and (c) to develop a better understanding of the pathophysiologic response of bone to injury and disease.

The exhibit demonstrated the method by means of models, "mock ups," photographs and roentgenograms. A self-contained projector showed time lapse motion picture sequences of fracture healing and osteomyelitis.

Angiocardiography, Its Indications and Some Technical Aspects. Erik Carlsson, M.D., Mallinckrodt Institute of Radiology, Washington University, St. Louis, Missouri. In this exhibit the value of angiocardiography in congenital heart disease was illustrated. Pertinent cases were included to show the diagnostic possibilities both in the selection of patients for operation and in the choice of surgical approach.

Roentgenographic Magnification. C. G. Coin, M.D., B. E. Mulvey, M.D., P. E. Russo, M.D., and Sister Mary Beatrice, R. T. FASXT, St. Antony Hospital, Oklahoma City, Oklahoma. This exhibit contained a collection of roentgenograms made by direct roentgen-ray magnification. The usefulness of this technique was demonstrated in the routine practice of radiology in a large general hospital, particularly in the diagnosis of difficult fractures and unusual malignant neoplasms.

The Cardiac Silhouette in Newborn Infants: What Significance? George Cooper, Jr., M.D., and James M. Carter, M.D., University of Virginia School of Medicine, Charlottesville, Virginia. Chest roentgenograms of 1,000 infants taken less than twenty-four hours after birth were reviewed in an effort to determine the limits of normal of the cardiac silhouette. Remarkably broad limits were found, and the reasons for this were presented. In addition, the mechanism leading to the appearance of roentgenographic abnormalities in the presence of congenital heart disease was illustrated.

Counters and Counting Technique in Diagnostic Isotope Procedures. K. E. Corrigan, Ph.D., and Henrietta S. Hayden, Ph.D., William Beaumont Hospital, Royal Oak, Michigan. The applications of various types of counting equipment and technical procedures to diagnostic problem cases were illustrated. The solution of such a problem depends on many factors among which are: (1) the proper choice of suitable equipment; (2) the counting procedure; and (3) careful choice of the time for each count in the necessary sequence.

Radiation Reactions in Mice. The Effect of Fractionation and Oxygen. Lucille A. DuSault, William R. Eyler, M.D., and Glen D. Dobben, M.D., Henry Ford Hospital, Detroit, Michigan. Skin reactions and systemic effects were compared for different fractionation techniques in mice given the same total dose in the same overall time. Reactions in mice treated with and without oxygen were also compared.

Both studies were made on spontaneous mammary adenocarcinomas in C_3H mice. The reactions and results obtained were illustrated by beautiful colored photographs.

Small Pneumoencephalograms As a Screening Procedure in Neuro Psychiatric Disorders. Lewis E. Etter, M.D., and Eugene L. Youngue, M.D., University of Pittsburgh, Pittsburgh, Pennsylvania, and Veterans Administration Hospital, Pittsburgh, Pennsylvania. This exhibit demonstrated the usefulness of small pneumoencephalograms employing only 20 cc. of air as a screening procedure for the study of the causes of convulsive disorders in 410 male veterans of the twenty-one to forty year age group. The procedure, which is one of a battery of diagnostic tests used, was adopted as a routine measure because of its simplicity, relative freedom from complications, fewer painful sequelae than with larger amounts of air and its diagnostic reliability, comparable to that of larger pneumoencephalograms.

Experimental Lymphadenography and Lymphangiography. Harry W. Fischer, M.D., State University of Iowa School of Medicine, Iowa City, Iowa. The feasibility of demonstrating abnormality of lymph node structure by contrast visualization has been investigated in the experimental animal. The available contrast materials have been evaluated for lymphangiography and lymphadenography in normal animals for detecting experimentally produced lymph node lesions.

Intragastric Irradiation in Man with Beta Rays of Ru-Rh 106. Benum W. Fox, M.D., M.S., Raymond Teplitz, M.D., Erwin M. Kammerling, M.D., and Armand Littman, M.D., Ph.D., University of Illinois College of Medicine, Chicago, Illinois. A model unit was demonstrated for intragastric beta irradiation in man using a cylindrical source of Ru-Rh 106. Dosimetry was discussed and the techniques of therapy were shown. The effects on gastric acidity and morphology were presented.

Osteoid Osteoma. Robert H. Freiberger, M.D., Milton Helpern, M.D., Bernard S. Loitman, M.D., and T. Campbell Thompson, M.D., Hospital for Special Surgery, Cornell University Medical Center, New York, New York. The observations made in 80 histologically proved cases of osteoid osteoma were presented in tables showing age and sex of patients, signs and symptoms and location of lesions. Roentgenograms and clinical photographs of selected cases were shown to demonstrate the diagnostic features which differ in various locations in the skeleton.

Induced Cardiac Arrest As an Aid to Contrast Cardiovascular Visualization. Louis H. Frische, M.D., and Charles T. Dotter, M.D., University of Oregon Medical School Portland, Oregon. A safe and effective method for visualizing coronary arteries had been developed by combining two entirely different techniques. These techniques are: (1) coronary arteriography by occlusion aortography, and (2) coronary arteriography during induced cardiac arrest.

The safety of the method has been established by temporarily occluding the ascending aorta on 1,000 occasions in 85 dogs. The cardiac arrest was induced by injecting acetylcholine through the catheter. As many as 18 arrests have been induced in a single animal in four hours without adverse effects. The method has also been used in the human, and in one patient arrest has been induced twice in succession. A dose up to 50 mg. acetylcholine was injected through the catheter in the human.

The technique was described in detail. The results were illustrated with roentgenograms and translites.

Placentography with Duo- and Tri-Speed Intensifying Screens. Abraham Geffen, M.D., Beth Israel Hospital, New York, New York. Single film lateral placentography providing for the differences in density and thickness of the anterior and posterior portions of the abdomen has been obtained by the use of combinations of portions of intensifying screens of different speeds in one cassette. Other uses of this technique were also demonstrated.

Roentgen Studies of Ventilatory Dysfunction: An Analysis of Diaphragmatic Movement in Obstructive Emphysema. Sumner Goldenthal, M.D., Robert Lowman, M.D., and Leonard Davis, M.D., Yale University Medical Center, New Haven, Connecticut. New techniques applied to roentgen kymography of the diaphragm permit a quantitative study of relationships between differential pulmonary ventilation and the amount and speed of diaphragmatic rise during forced rapid expiration. A rapid, economic and atraumatic screening procedure was developed for the detection and permanent recording of ventilatory dysfunction. This procedure was described in detail and illustrated.

Diagnosis and Treatment of Pulmonary Embolism. Harold L. Israel, M.D., Dick D. Harrell, M.D., Albert Sheffer, M.D., and George N. Stein, M.D., Graduate Hospital, University of Pennsylvania, Philadelphia, Pennsylvania. The material of this exhibit included an analysis of 90 patients diagnosed as having a pulmonary embolism, with special emphasis on assessing the value of the roentgenologic examination in this condition. The roentgen characteristics and distribution of lesions have been tabulated as well as the data concerning the time elapsed from onset of symptoms until roentgen changes became identifiable. Serial films, available in most surviving patients, have been reviewed in order to measure the rapidity of clearing of the roentgen abnormalities. Roentgenograms

showing the most common abnormal patterns were presented. The exhibit also included a description of the clinical and electrocardiographic changes characteristic of pulmonary embolism. The current concept of therapy for pulmonary embolism was illustrated.

Lower Intestinal Obstruction of Infancy. Robert J. Izant, Jr., M.D., and William H. R. Howard, M.D., Ohio State University School of Medicine, The Children's Hospital, Columbus, Ohio. Since intestinal obstructions are one of the common causes of death in the neonatal period, early and exact preoperative diagnosis is of major importance in the salvation of these infants. The exhibitors presented a review of several causes of obstruction together with a method of work-up to arrive at a diagnosis in the minimum length of time and without undue radiation exposure to the child.

Pulmonary Torulosis. Lewis G. Jacobs, M.D., Veterans Administration Hospital, Oakland, California. Pulmonary torulosis as a cause for an asymptomatic solitary nodule in the lung has been given little attention. The increasing frequency of excision of such nodules to exclude cancer has led to a microscopic diagnosis of torulosis in 8 instances during the last ten years at the exhibitor's hospital. This suggests that the solitary nodule is a more common finding than better recognized lesions of *Torula* infection. The various aspects of the problem were presented.

Respiratory Distress in the Newborn. George Jacobson, M.D., and Victor G. Mikity, M.D., University of Southern California, School of Medicine and Los Angeles County Hospital, Los Angeles, California. Respiratory distress in the newborn can be attributed to many causes. However, only those of pulmonary origin were considered in this exhibit. They included: hyaline membrane syndrome; aspiration of amniotic fluid; staphylococcus pneumonia; interstitial mononuclear pneumonitis; necrotizing bronchopneumonia; tuberculosis; adenomatoid malformation; pulmonary edema; and lobar and interstitial emphysema.

The roentgenologic manifestation of most of these entities can be strikingly similar. It was stressed that they cannot be differentiated on roentgenologic grounds alone, but that careful consideration must be given to the history, physical and laboratory findings.

The Navy Medical Nuclear Reactor. Captain E. R. King (MC) USN, Captain S. F. Williams (MC) USN, Commander Thomas Shea (MSC) USN, and Lieutenant T. G. Mitchell (MSC) USN, Bureau of Medicine and Surgery, Department of the Navy, Washington, D. C. The development of the five-watt medical reactor and the installation of such a reactor at the Naval Hospital made it possible for the first time to produce short half-life radioisotopes locally in close proximity with the patients on whom they are used. By having this facility available at the hospital, it opens up an entirely new field in the utilization and investigation of radioactive isotopes of short half-life which provide the same diagnostic information as the longer half-life isotopes without subjecting the patients to excessive amounts of internal body irradiation. In addition to the manufacture of radioactive isotopes, the reactor is used for research studies on the effects of neutron irradiation of biologic materials, and for instruction of medical officers, Nurse Corps officers and enlisted Hospital Corps isotope technicians.

The exhibit illustrated the construction, operation and the various clinical phases of this reactor.

Intestinal Obstruction and Adynamic Ileus —Roentgen Differentiation. I. E. Kirsh, M.D., and George F. Koptik, M.D., Veterans Administration Hospital, Hines, Illinois. Plain roentgenograms of the abdomen in different positions are helpful in establishing a diagnosis of intestinal obstruction and making a differential diagnosis between it and adynamic ileus. Representative roentgenograms of an assortment of pathologic conditions were presented.

Myelofibrosis. Ted F. Leigh, M.D.,

Charles C. Corley, Jr., M.D., Charles M. Huguley, Jr., M.D., and James V. Rogers, Jr., M.D., Emory University Hospital, Emory University, Georgia. The roentgen findings, including those in bones, spleen, liver, and other organs, were shown. The relative frequency of bone changes in proved cases was evaluated. The differentiation from other diseases causing bone sclerosis, hepatomegaly, and splenomegaly was illustrated.

Presacral Retroperitoneal Pneumography: A Safe Method Utilizing CO_2. Robert McLelland, M.D., Charles L. Ransom, M.D., and Ralph R. Landes, M.D., The Memorial Hospital, Danville, Virginia. This exhibit presented the evolution and technique of a new safe method of presacral retroperitoneal pneumography using CO_2, illustrated with artist's drawings and representative roentgenograms.

The Regional Manifestations of Scleroderma. William T. Meszaros, M.D., Cook County Hospital, Chicago, Illinois. Scleroderma affects many regions of the body, usually in a characteristic manner. The radiologist should be aware of all possible manifestations, to assure early and precise diagnosis. This exhibit illustrated the most common of such manifestations.

Aortic Valvulography and Ascending Aortography. William Molnar, M.D., Sidney W. Nelson, M.D., Karl P. Klassen, M.D., and Joseph M. Ryan, M.D., Ohio State University Hospital, Columbus, Ohio. An angiographic technique was presented which permits accurate visualization of the function of the aortic valves to differentiate between a Graham-Steell type of murmur due to pulmonary hypertension and that caused by aortic insufficiency in candidates for mitral commissurotomy. The method also allows simultaneous visualization of the coronary arteries and demonstration of the thoracic aorta.

Case of the Day. Richard Mulvey, M.D., C. Donald Noonan, M.D., and Gaston Mendez, M.D., Cincinnati General Hospital, Cincinnati, Ohio. This exhibit consisted of a series of interesting and unusual proved cases aimed to tax the roentgen diagnostic acumen of the viewers. One case was exhibited each day and a "padlocked mailbox" was available for the answers submitted by radiologists. The answers were tabulated each evening. The following day the answer sheet containing the diagnosis, a brief description of the findings, pertinent references, and a list of the winners was posted along with a new case.

This teaching method was patterned after one employed successfully for a number of years in the Department of Radiology at Cincinnati General Hospital.

Visualization of Cerebellopontine Cisterns with Small Amounts of Air in the Differential Diagnosis of Acoustic Tumors. Frederick Murtagh, Jr., M.D., M.S., and Herbert M. Stauffer, M.D., M.S., Temple University Medical Center, Philadelphia, Pennsylvania. The method of visualization of the cerebellopontine cisterns by controlled pneumoencephalography was presented. Several examples of visualization were demonstrated and examples of the visualization of acoustic tumors were also shown.

Emphysema Studied by Microradiography. Charles Oderr, M.D., Philip Pizzalato, M.D., and Joseph Ziskind, M.D., Veterans Administration Hospital, New Orleans, Louisiana. This exhibit demonstrated localizations and character of early emphysematous lesions, and their possible relationship to lymphatics, pores of Kohn and other anatomic structures. Fenestrations in air sac walls are believed to be the basic lesions in emphysema and these alone could account for collapse of bronchioles during expiration. A model to demonstrate this had been constructed.

Bronchography in the Pre-surgical Patient. Anton M. Pantone, M.D., Noble Correll, Jr., M.D., Myron Melamed, M.D., and Hiram T. Langston, M.D., Chicago State Tuberculosis Sanitarium, Chicago, Illinois. The material for this exhibit was selected from 900 rapid bilateral bronchograms and from a few selective visualizations of individual bronchi. The exhibit demonstrated the value of visualizing the whole bronchial

tree preceding surgery and the ease with which this may be accomplished in the majority of cases.

Pantopaque Ventriculography in the Diagnosis of Posterior Fossa Lesions. Bruce L. Ralston, M.D., Sidney W. Gross, M.D., and Charles M. Newman, M.D., The Mount Sinai Hospital, New York, New York. The usefulness of pantopaque ventriculography in the recognition and localization of expanding and obstructive lesions of the posterior fossa was shown. The technique presented by the exhibitors does not require manipulation under fluoroscopic control and is therefore simple to perform. The procedure is recommended in cases in which air studies have been unsatisfactory or equivocal and in which surgical intervention is anticipated.

Plastic X-Ray Phantoms. Joseph F. Roderick, R.T., A.S.X.T., C.S.R.T., Pine Ridge, New Brunswick, New Jersey. Durable phantoms and roentgenograms made using them were exhibited. The phantoms consisted of human bones embedded in uncolored, transparent material, identified as Bio-Plastic. The difference between the absorption coefficients of this plastic and bone is essentially the same as that between the absorption coefficients of human tissue and bone in the 40 to 130 kv. peak range. The phantoms are valuable in teaching and studying roentgenographic procedures. They permit both a continuation of research and a reduction in radiation exposure to human beings.

Long-Film Functional Ascending Phlebography of Lower Extremity: Evaluation of Techniques; Anatomic and Functional Detail. Stanley M. Rogoff, M.D., and James A. DeWeese, M.D., University of Rochester School of Medicine and Dentistry, Rochester, New York. With tourniquet above the ankle and patient in a 60 degree semierect position, slow injection of 40 cc. of 50 per cent hypaque is made into a superficial vein on the dorsum of the foot. One 34 inch long film is exposed before exercise and another following release of tourniquet and performance of standard exercise. The advantages of this functional technique are: (1) increased frequency of visualization of all deep veins of the lower leg and thigh on one examination, and (2) demonstration of the functional response of the deep, collateral and communicating veins after exercise. One hundred extremities have been examined to date (April, 1958). The method was first evaluated by tabulating anatomic and functional data obtained from normal extremities and those with known deep vein abnormalities. These data have proved valuable in establishing the diagnosis and suggesting rational therapy for patients with complicated varicose vein problems, unexplained swelling of the leg, recent phlebitis, and equivocal histories of recent or old deep phlebitis.

Perspiration Salt Test and Duodenal Ulcer Activity. William Snow, B.S., M.D., Veterans Administration Hospital, Shreveport, Louisiana. A new method to determine duodenal ulcer activity was presented.

Stress reaction causes salt retention. The Perspiration Salt Test shows salt retention with active duodenal ulcer. A series of 621 cases was reviewed and the technique used was illustrated.

Crystal Detectors for X-Radiation. Elmer G. St. John, M.D., and Earl Fish, R. T., Binghamton City Hospital, Binghamton, New York. Cadmium sulfide crystals can be used for the detection and measurement of roentgen and gamma radiation. The electrical resistance of these crystals falls in roughly linear fashion when exposed to roentgen-ray quanta inversely with quantity. Sensitivity is high and accuracy is good. It is possible to detect as little as 10^{-4} r/min. by this method.

Inasmuch as these crystals can be made very small, they can be placed within tissues and direct readings of radiation intensity can be made. Calibration of these crystals against thimble ionization chambers is mandatory. The exhibit presented a cadmium sulfide crystal detector in operation and gave pertinent data of interest.

Polaroid "Spot" Filming with Image Intensification. Herbert M. Stauffer, M.D.,

Archie W. Blackstone, E.E., and Edward E. Christensen, M.D., Temple University Hospital, Philadelphia, Pennsylvania. In this procedure a Polaroid Graflex camera back is adapted to a Phillips image intensifier and spot roentgenograms are taken on the new Polaroid-Land projection film. An $8\frac{1}{4}$ focal length is employed with the camera back and an image of 2 inches in diameter is obtained. This image is perfectly adequate for direct viewing and can also be projected readily.

Several Polaroid spot roentgenograms and convention spot roentgenograms of the same areas had been taken and were demonstrated for comparison.

Roentgen Studies of the Fractured Pelvis: The Principles and Application of a New Technique. Gordon O. Sutherland, B.Sc. (E.E.), M.D., and Wallace M. Roy, M.D., St. Joseph's Hospital, Toronto, Ontario, Canada. This exhibit demonstrated and interpreted special roentgen studies of the fractured pelvis. A technique was described for obtaining roentgenograms which revealed precisely the position of the fractured bones and the associated abnormalities of articulation at the sacroiliac joints. Diagrams, models, and roentgenograms of specimens were used to illustrate the principles of the technique and the roentgen anatomy. Selected case studies showed some basic fracture patterns, and these were correlated to the mechanics of injury. A description was given of how the special roentgenograms aid in treatment and in the evaluation of disability resulting from pelvic injuries.

Reactions to Reactions. John F. Weigen, M.D., and Sydney F. Thomas, M.D., Palo Alto Medical Clinic, Palo Alto, California. This exhibit presented the materials and plan of action required to combat reactions from intravenous organic iodide compounds.

THE COMMERCIAL EXHIBITS

The Commercial Exhibits of the Fifty-ninth Annual Meeting of the American Roentgen Ray Society, held at the Shoreham Hotel, Washington, D. C., September 30 to October 3, 1958 greatly exceeded the already high standard which the Society has come to expect, particularly since the advent of the atomic age. The many new advances in the construction of equipment for the diagnostic and therapeutic uses of the various forms of radiation and isotopes have brought forth a dazzling array of apparatus displayed in a most artistic manner. The individual arrangements, which were carried out with utmost care, were all excellent and evoked great admiration from the many visitors. The placing of all the scientific papers in the morning had afforded them ample time to study the minute details of these latest technical achievements, and the enthusiastic interest shown must have been most rewarding to the exhibitors. The unusual facilities of the Shoreham Hotel, and the tireless work of Mr. Clifford L. Sherratt, Honorary Member, and Dr. James C. Cook, Manager of the Annual Meeting, were additional factors which contributed to the over-all success of the Commercial Exhibits and thereby enhanced the attractiveness of the Annual Meeting as a whole. The Society extends to all exhibiting firms its profound appreciation and sincerest thanks.

The following is the list of the firms which participated in the Commercial Exhibits:

Abbott Laboratories, North Chicago, Illinois; American Electronics, Culver City, California; Ansco, Binghamton, New York; Atomic Energy of Canada Limited, Ottawa, Ontario, Canada; Automatic Seriograph Corporation, College Park, Maryland; Barnes-Hind Barium Products Company, Sunnyvale, California; Carr Corporation, Culver City, California; Coreco Research Corporation, New York, New York; Dick X-Ray Company, St. Louis, Missouri; Dunlee Corporation, Chicago, Illinois; E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware; Eastman Kodak Company, Rochester, New York; Eureka X-Ray Tube Corporation, Chicago, Illinois; Fairchild Camera and Instrument Corporation, Syosset, Long Island, New York; L. M. Forsyth X-Ray Corporation, Chicago, Illinois; E. Fougera & Company, Inc., Hicksville, Long Island, New York; Franklin X-Ray Corporation, Philadelphia, Pennsylvania; General Electric Company, Milwaukee, Wisconsin; Gray Pharmaceutical Company Inc., Newton, Massachusetts; Grune & Stratton, Inc., New York, New York; Halsey X-Ray Products, Inc., Brooklyn, New York; Paul B. Hoeber, Inc., New York, New York; Hospital Microfilming, Pearl River, New York; Howdon Videx Products Corporation, Mount Vernon, New York; Ilford Inc., New York, New York; Keleket X-Ray Corporation, Waltham, Massachusetts; Leishman X-Ray Engineering Company, Los Angeles, California; Liebel-Flarsheim Company, Cincinnati, Ohio; LogEtronics Inc., Alexandria, Virginia; Low X-Ray Film Corporation, New York, New York; Machlett Laboratories, Incorporated, Springdale, Connecticut; Mallinckrodt Chemical Works, St. Louis, Missouri; Mattern X-Ray Division of Land-Air, Inc., Chicago, Illinois; Medical Case History Bureau, New York, New York; Micro X-Ray Recorder, Inc., Chicago, Illinois; North American Philips Company, Inc., New York, New York; Nuclear-Chicago Corporation, Chicago, Illinois; Pako Corporation, Minneapolis, Minnesota; Pelvic Anchor Corporation, Rochester, New York; Physicians' Technical Equipment Company, Milwaukee, Wisconsin; Picker X-Ray Corporation, White Plains, New York; Profexray, Incorporated, Maywood, Illinois; Schick X-Ray Company, Inc., Chicago, Illinois; Frank Scholz X-Ray Corporation, Boston, Massachusetts; Siemens New York Incorporated,

New York, New York; Standard X-Ray Company, Chicago, Illinois; Charles C Thomas, Publisher, Springfield, Illinois; United States Radium Corporation, Morristown, New Jersey; Victoreen Instrument Company, Cleveland, Ohio; Westinghouse Electric Corporation, Pittsburgh, Pennsylvania; Winthrop Laboratories, New York, New York; X-Ray Monitoring Corporation, New York, New York; X-Ray Solution Service, Detroit, Michigan; Year Book Publishers, Inc., Chicago, Illinois.

SOCIETY PROCEEDINGS AND NEWS ITEMS

THE ELEVENTH ANNUAL MID-WINTER RADIOLOGICAL CONFERENCE

The Eleventh Annual Mid-Winter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Statler Hotel, Los Angeles, California, on Saturday and Sunday, January 31 and February 1, 1959.

An outstanding program of pertinent interest has been arranged and the guest speakers will be: Dr. Peter Kerley, London, England; Professor D. W. Smithers, London, England; Dr. F. N. Silverman, Cincinnati, Ohio; Dr. A. Finkelstein, Philadelphia, Pennsylvania.

The conference fee of $20.00 includes two luncheon meetings featuring Questions and Answers. A banquet ($7.50 per plate) preceded by cocktails will be held Saturday evening. Reservations may be made through Dr. Chester P. Bonoff, 1930 Wilshire Blvd., Los Angeles 57, California.

Courtesy cards will be available to residents in Radiology and radiologists in the Armed Forces by advance registration, with reduced tariff for the luncheons and banquet. Hotel reservations should be made promptly through the Convention Manager, Statler Hotel, Los Angeles, California.

INTERNATIONAL ATOMIC ENERGY AGENCY SURVEYS LATIN AMERICA

At the request of the Latin American Countries, the International Atomic Energy Agency this spring and summer sent a survey team of experts to investigate the needs for the establishment of a training center or centers in the peaceful use of atomic energy in Latin America. The team visited all but three of the twenty Latin American Countries and ranged as far south as 1100 miles below Buenos Aires. The head of the mission was Dr. Norman Hilberry, Director of the Argonne National Laboratory. Other members of the mission were: Dr. Harold Sheard of the United Kingdom Atomic Energy Authority and Dr. Alfred Carcasses, a Sub-Director of the French atomic energy installation at Saclay, France. Dr. Mario E. Bancora of Argentina represented the International Agency. Advisors to the mission were: Dr. James W. J. Carpender, advising in medicine and biology, from the University of Chicago; Dr. French Hagemann, advising in chemistry, from the Argonne National Laboratory; and Dr. Nathan Woodruff, advising in biology and agriculture, of the United States Atomic Energy Commission office in Buenos Aires. Observers from the Organization of American States were: Dr. Luiz Cintra do Prado, of São Paulo University, Brazil; and Dr. John K. Rouleau, of the Latin American Division of the United States Atomic Energy Commission. As an observer from the Economic Commission for Latin America, there was Dr. Francis Silvart of Santiago, Chile. The executive secretary was Mrs. Ulrika Schiller. At the end of the trip in Mexico City, the group flew to Vienna, Austria, where a report to the International Atomic Energy Agency was made.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. LEUCUTIA, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Neck and Chest

Parish, Christopher. The clinical features of intrathoracic neurogenic tumours. *J. Fac. Radiologists*, Oct., 1957, *8*, 381–384. (From: Papworth and Addenbrooke's Hospitals, Cambridge, England.)

Nineteen cases of intrathoracic neurogenic tumors were studied; eight of these were symptomatic and are reported herewith. In the 11 asymptomatic cases the tumors were coincidental,—10 being benign and 1 doubtfully malignant. Of the 8 symptomatic patients, 5 had malignant and 3 benign tumors.

The symptoms may be pulmonary, neurologic, alimentary and cutaneous. The pulmonary symptoms include hemoptysis, dyspnea, pleural effusion, recurrent pneumothorax, asthmatic attacks, stridor from tracheal obstruction, atelectasis, emphysema, recurrent pneumonia, and persistent cough. The neurologic symptoms which may be present are neuralgia affecting the nerve of origin of the tumor, spinal cord symptoms due to dumb-bell extension or malignant vertebral invasion, Horner's syndrome, and shoulder-tip pain due to diaphragmatic "irritation." Digestive symptoms of flatulence, dysphagia and vomiting have been noted. Cutaneous manifestations may be observed at times and these may include multiple subcutaneous nodules and skin pigmentation.

The following conclusions are reached: (1) The absence of symptoms in cases of suspected intrathoracic neurogenic tumors is more common in those which had not undergone malignant change; (2) the presence of apparently serious symptoms, such as hemorrhagic pleural effusion, does not necessarily indicate malignancy; (3) large recurrences of border line malignant tumors can occur twelve years after initial excision, and can be excised in elderly patients, though frankly sarcomatous changes may have supervened; (4) the presenting symptoms of intrathoracic neurogenic tumors are extremely varied; (5) sudden blood pressure changes during operative removal of unknown intrathoracic tumors should suggest the diagnosis of pheochromocytoma; and (6) thoracotomy should be advised in all cases of suspected intrathoracic neurogenic tumors, whether or not they are symptomatic.—*Samuel G. Henderson, M.D.*

Gregg, Duncan McC. Some radiological aspects of primary intrathoracic neurogenic tumours; based on a review of 19 cases. *J. Fac. Radiologists*, Oct., 1957, *8*, 385–393. (From: Papworth and Addenbrooke's Hospitals, Cambridge, England.)

A large proportion of reported intrathoracic neurogenic tumors has been asymptomatic, and accidentally discovered by mass roentgenography chest surveys or by roentgen examination of the chest for exclusion purposes. The paravertebral gutter and the posterior part of the mediastinum where both autonomic and intercostal nerves lie close together are the common sites of origin of these tumors.

Roentgen Appearance. The size of the intrathoracic neurogenic tumors exhibits wide variations,—from pigeon's egg size to a mass occupying the greater part of a hemithorax. They have clearcut, well-defined margins and are usually rounded or ovoid. Slight lobulation, border irregularity or segmental straightening of contour of the tumor may be a sign of cystic, degenerative, or even malignant changes within the tumor. Laminagraphy is of particular value in such cases, and may demonstrate adjacent bone erosion and sclerosis, or tumor calcification. Rapid increase in size of the mass, increased lobulation or irregularity and loss of clear marginal definition may indicate malignancy. A "collar-button" tumor described by Kornblum and Bradshaw in 1941, which erodes the intervertebral foramen from without and grows inward, is not uncommon, but it seldom produces neurologic signs.

It is often possible roentgenologically to differentiate between ganglioneuroma and neurofibroma if the tumor is small. The small ganglioneuroma in the posteroanterior projection has a broad base adjacent to the mediastinum, whereas a similarly situated small neurofibroma often appears rounded medially and has a narrow base. The tumor-mediastinal angle is more acute with neurofibroma, and in the ganglioneuroma it is often obtuse.

Differential Diagnosis. Cystic conditions such as dermoid, teratoma, tracheal, bronchogenic, gastrogenous, hydatid, and pleuropericardial cysts arising in an abnormal or more posterior position than usual must be considered in differential diagnosis in the case of posterior or apicoposterior neurogenic tumors. In loculated posterior pleural effusions or empyema, the lower border is often well defined and the upper border is not clearly differentiated although otherwise such lesions might be mistaken for neurogenic tumors. The shape of the loculation is sometimes oval in one projection with the margins tapering into the pleural edges, unlike the pleural reflection around the extrapleural neurogenic tumor. Other lesions to be considered in differential diagnosis include retrosternal goiter, thymic tumors, primary tumors of ribs, spine and pleura, extrapleural hematoma, lipoma, and meningocele, and occasionally an aortic aneurysm. While intrathoracic neurogenic tumors arising in sites other than the paravertebral gutter are much less common, nevertheless primary pulmonary tumors, solitary metastases, granuloma, hamartoma, abscess and pulmonary arteriovenous aneurysm must be differentiated.—*Samuel G. Henderson, M.D.*

Pollitzer, Guido, and Pollitzer, Guido R. Imágenes radiólogicas del pulmón del poliomielítico respiratorio. (Radiologic images of the lungs of patients with poliomyelitis) *An. Cáted. pat. y clín. tuberc.*, 1956, *18*, 39–71. (From: Hospital F. J. Muñiz, Buenos Aires, Argentina.)

In the 1956 outbreak of poliomyelitis in Buenos Aires, the authors could obtain roentgenologic data on 135 patients with respiratory complications. Because most of them were confined to a respirator, the taking of roentgenograms was a delicate and tedious operation; the patients were supine and anteroposterior views only could be obtained. This required careful interpretation of the roentgenograms and, in fact, proper evaluation of the roentgenologic images and correlation with the clinical course of the disease were done *a posterori*.

An early finding, occurring a few days after the onset of the disease, was a narrowing of the shoulders with medial displacement of the scapula, due to atrophy of the thoracic and shoulder muscles. After several weeks there may be a lateral and downward displacement of the shoulders, so that their upper limit is at the level of the fifth dorsal vertebra. The ribs also fall downward and when this is not accompanied by alterations in the position of the shoulder bones, the thoracic cage takes an odd configuration as if shrunk away from the shoulders. Unilateral or, more commonly, bilateral paralysis of the diaphragm occurred in 76 per cent of the cases; this paralysis, however, was usually only transitory. One has to be careful not to overdistend the lungs when taking the roentgenograms, lest the upward displacement of the paralyzed diaphragm be masked. On the other hand, in the recovery stage when the patient is already breathing on his own, it is not rare to observe paradoxic movements of the diaphragm, due to exaggerated use of the neck and shoulder muscles for breathing purposes. In the abdomen, enlargement of the spleen and liver are usually seen, persisting several weeks and being more pronounced in small children. Another frequent finding is dilatation of the stomach and intestines, probably related to relaxation of the abdominal wall and alterations in the smooth muscle.

Frank pleural effusions were observed in 4.4 per cent of the cases; probably small effusions were not clearly recognized because the patients were supine. In 4 cases spontaneous pneumothorax was observed and half of these died; the patients developing pneumothorax while in the respirator are in great danger, because if the condition is not recognized, an enormous amount of air is collected in the pleural cavity which herniates in the abdomen.

Mediastinal widening occurs fairly frequently and it is mostly a secondary change due to paralysis of the diaphragm. Mediastinal lymph node enlargement is infrequently seen. At times the widening may be accounted for by mediastinitis, which may follow tracheostomy.

A diffuse clouding of the lung fields, through which the bronchial markings could still be seen, was a fairly frequent observation in patients with cyanosis and dyspnea. This image promptly disappeared once the respirator took care of the patient's respiratory needs. A scattering of small rounded, nonconfluent densities occurred in patients with impaired swallowing mechanism or with abundant secretions; they are probably due to tiny atelectases and they clear up with tracheal aspirations. Another finding with a good prognosis is a typical image of bronchiolo-alveolitis, the nature of which is not known. Two patients developed multiple foci of bronchopneumonia with fatal outcome. In some cases a diffuse bilateral clouding may be observed which in a few hours spreads to the whole lung parenchyma, giving a roentgenologic appearance very similar to acute pulmonary edema. Clinically, these patients died in a short time with acute respiratory failure. Atelectases and pneumonitis were fairly common, and their differentiation is relatively easy, if attention is paid to accompanying signs such as retraction of the diaphragm, ribs, and interlobar fissure. This is of great clinical importance, because aspiration promptly solves atelectases while pneumonitis, of much graver prognosis, is not affected in any way by it.—*Francisco Comas, M. D.*

Thomson, James, and Forfar, John O. Regional obstructive emphysema in infancy. *Arch. Dis. Childhood*, April, 1958, *33*, 97–108. (From: The Royal Infirmary, Dundee, and the Western General Hospital, Edinburgh and from the Departments of Child Health, University of St. Andrews and University of Edinburgh, Edinburgh, Scotland.)

The authors proposed a classification of emphysema occurring in infancy according to the site of the valvular obstruction. The 3 groups are: (1) lobar emphysema, where the obstruction is intrinsic or extrinsic to the main stem bronchi; (2) lobular emphysema, in which the valve phenomena are present in the smaller bronchi or bonchioles (and the interalveolar pores of Kohn are obstructed to the degree to allow a trapping of air); and (3) cystic obstructive emphysema, where the valve is at the alveolar level.

Gross examples of regional obstructive emphysema in infancy are presented and illustrate a variety of pathologic conditions in which this disorder may occur. Lobular emphysema may be secondary to congenital malformations or to intra- or extrabronchial abnormalities. The intrabronchial abnormalities include foreign bodies, mucus or mucopus, mucosal swelling and granulation tissue. The extrabronchial conditions comprise enlarged heart, enlarged hilar lymph nodes, extrabronchial

cysts and aberrant blood vessels including ductus arteriosus. The lobular emphysema occurs following bronchiole obstruction in a regional distribution. This may occur secondary to aspiration of vomitus, mucus, amniotic fluid or mucosal swelling. The cystic type occurs with congenital retention cysts and acquired postpneumonic cysts.

Cases are presented which demonstrate these classifications. Some unusual cases of emphysema in infancy are described. The roentgenographic differentiation of primary and compensatory emphysema is presented. Treatment is touched upon and the indications for surgical intervention are discussed.—*James F. Martin, M.D.*

Vaccarezza, Raúl F. (Buenos Aires, Argentina.) El problema de la neumonoconiosis en nuestro país; aspectos clínicos y sociales. (The problem of pneumoconiosis in our country; clinical and social aspects.) *An. Cáted. pat. y clín. tuberc.*, 1956, *18*, 5–38.

On the basis of a long experience with this disease, and reporting 16 new cases to illustrate his points, the author comments on the vagaries of pneumoconiosis in relation to time of appearance after exposure to the causative agent, etiologic factors, clinical course, and development of tuberculosis. He briefly reviews the social legislation enacted in several foreign countries and Argentina dealing with industrial hygiene and compensation policies, and finds it for the most part greatly inadequate. A strong plea is made for better protection of the worker, including prohibition of especially dangerous procedures such as the use of a sand jet for glass engraving, and for new legislation that will take into account the long latent period of this disease and the permanent disability it causes.—*Francisco Comas, M.D.*

Woodruff, John H., Jr., Ottoman, Richard E., and Isaac, Frank. Bronchiolar-cell carcinoma. *Radiology*, March, 1959, *70*, 335–348. (Address: J. H. Woodruff, Jr., 1124 W. Carson St., Torrance, Calif.)

Bronchiolar carcinoma, also called alveolar-cell carcinoma, pulmonary adenomatosis, papillary adenocarcinoma, and mucous carcinoma, is a recognized clinical and pathologic entity, which in its behavior, location and relatively benign histology is quite different from bronchogenic carcinoma. Bronchiolar carcinoma is a primary lung tumor probably originating in the terminal bronchioles, has a relatively benign histologic appearance, and as a rule does not destroy the normal pulmonary tissue. Tumor masses, which may be multiple or solitary, varying in size from a few millimeters in diameter to masses involving the whole lung, which tends to be expanded, may be found. Major bronchi may rarely be invaded late in the course of the disease; however, focal atelectases and superimposed infection are not uncommon. Pleural involvement may produce serosanguineous pleural effusions. Metastatic spread may occur by extension to contiguous areas, by the lymphatics, and by the blood stream. Extension by tumor implants throughout the bronchial tree and multicentric origin rather than spread from a primary focus are controversial subjects. There are no characteristic clinical or physical findings. Death occurs within one year after symptoms develop in about two-thirds of the cases, and within four years in the remaining third. A very small number survives more than four years.

The roentgenologic findings depend on the stage of the tumor and whether or not dissemination has occurred. There are no sites of predilection. The lesion begins in the peripheral portion of the bronchial tree where satellite foci are likely to occur. These lesions tend to progress in size and coalesce to form a much larger lesion over a period of months or years, but at times they may appear to be static or appear to clear as their pneumonic or focal atelectatic components resolve. The margins of the shadows may be fairly sharp and discrete or very indistinct and diffuse. Dissemination to the same and opposite lung occurs at various stages of development. The primary lesion may be so small that roentgen demonstration is impossible, or the significance the shadow produces may be misinterpreted. Small solitary lesions must be differentiated from small granulomatous scars. Development of satellite "scars" or increase in size should arouse suspicion. The presence of calcification in the lesion would be evidence against bronchiolar carcinoma but would not exclude it. The larger localized tumors may mimic chronic pneumonia. Continued progress and lack of resolution should certainly be investigated. The character of the primary and secondary lesions is not necessarily the same, as one may be nodular and the other infiltrative, and vice versa. Cavitary lesions are seen but are uncommon. Pleural effusions may obscure the primary lung tumor. Once dissemination has developed, the diagnosis is more apparent, but unfortunately by this time hope for surgical cure has been lost. Mediastinal adenopathy is not a common roentgenographic finding. Bronchography may show a uniform, diffuse, rather marked narrowing of the segmental bronchi in the areas of lung involvement; rigidity and elongation of the bronchi; filling rather than coating of the bronchi; and a lack of filling of the terminal ramifications of the bronchi or of the alveoli of the lung segments supplied by these bronchi.

Most diagnoses have been made at autopsy or on surgical specimens. Bronchoscopy, aspiration biopsy, and cytologic study are of limited value. Exploratory thoracotomy appears to be indicated when necessary for the diagnosis of treatable cases. In operable cases lobectomy is the treatment of choice. The results of radiation therapy have been dis-

couraging. Sixteen cases are presented.—*Walter H. Jarvis, Jr., M.D.*

LIN, T. K., DIEHL, ANTONI M., and KITTLE, C. FREDERICK. Hemodynamic complications in tetralogy of Fallot after pulmonary valvectomy or infundibulectomy (Brock procedure). *Am. Heart J.*, Feb., 1958, *55*, 288–303. (From: The Departments of Medicine, Pediatrics, and Surgery of the University of Kansas School of Medicine, Kansas City, Kans.)

This article is a report of serious postoperative complications in 3 cases, from a series of 25 patients with tetralogy of Fallot, in whom a Brock procedure was done. The case reports are given in detail along with the catheterization findings and roentgen studies. Two of the 3 patients died several months to a year postoperatively with heart failure.

Shortly following surgery the 3 patients showed marked improvement with disappearance of cyanosis, increase in exercise tolerance and a feeling of well being. Prior to surgery all showed roentgen signs of very slight transverse cardiac enlargement and right ventricular enlargement associated with decreased pulmonary vasculature.

Postoperatively there was an increase in the intensity of the pulmonary systolic murmur and a diastolic murmur appeared. It was felt that this represented pulmonary regurgitation. Also the fluoroscopic studies and roentgenograms revealed progressive biventricular enlargement, active forceful ventricular pulsations, increased pulmonary vasculature and excessive pulsations of the pulmonary arteries.

There was an increase in the mean pressure of the caval and right atrial pressures postoperatively which was felt to be due to ventricular failure. The wedge pressure was markedly increased. With the fall in pulmonary outflow resistance, the peripheral oxygen saturation was increased. Blood flow calculations showed the development of a large left to right shunt through a ventricular septal defect. The major factors controlling the direction of the shunt were the relative pulmonary and systemic resistances and the size of the ventricular defect rather than the overriding aorta. Also the resultant right bundle branch block may further aggravate the left to right shunt.

The systolic pressures in both ventricles were the same both pre- and postoperatively. It probably can be said that they would function as a common ventricle. With a sudden reversal of the shunt and the development of pulmonary regurgitation, of a variable degree, a failure of the "common ventricle" is produced.

It is concluded that because of the potentially serious cardiophysiodynamic changes which occur postoperatively and since the ventricular defect is not repaired, this surgical approach to tetralogy of Fallot should be considered only as palliative and not without hazard.—*John Gwinn, M.D.*

McLAREN, J. R., and BAYLIN, GEORGE J. Two cases of aneurysms of the sinus of Valsalva with interesting roentgen changes. *Radiology*, March, 1958, *70*, 362–367. (From: Department of Radiology, Duke University, Durham, N.C.)

The authors report 2 cases of aneurysm of the sinus of Valsalva which show roentgen changes usually seen in other types of heart disease. This type of aneurysm may so distort the aortic valve that regurgitation ensues, or the coronary artery orifice may be involved with resulting coronary insufficiency or occlusion. It may extend sufficiently to encroach on the cardiac chambers or the atrioventricular valves. Perforation leads to an aortic cardiac shunt which is usually to the right heart, causing heart failure and this is the most frequent cause of death. There are no roentgen signs of the aneurysm because of its intracardiac location; however, in complicated cases there may be marked roentgenographic changes as in the 2 cases reported by the authors. In the event of perforation, there will be marked cardiac enlargement and signs of congestive failure.

An autopsy of one of the cases revealed the sequelae of long standing heart failure; all the heart chambers were enlarged and there was aneurysmal dilatation of the left coronary and noncoronary aortic sinuses with multiple perforations into the left ventricle. Both aneurysms had extended to and involved the aortic leaflet of the mitral valve and encroached upon the left atrium. The aortic valves and aortic sinuses revealed evidence of chronic inflammation, and the aneurysm was considered to be of inflammatory origin. These findings helped to explain the roentgen changes of cardiac enlargement and prominent pulmonary vasculature which suggested a mitral valvular lesion. Autopsy of the second case revealed a large aneurysmal dilatation of the sinus of Valsalva which narrowed the inflow tract of the right ventricle and extended from above the cusp of the aortic valve into the right ventricular space. This encroachment of the 6.5 cm. aneurysm upon the right ventricle had markedly limited the flow of blood through the right ventricle and explained the marked diminution in size of the pulmonary vessels as well as the cardiac enlargement seen on the roentgenograms. This second case was considered to be of congenital origin.—*John S. Alexander, M.D.*

HIRST, ALBERT E., JR., and BARBOUR, BENJAMIN H. Dissecting aneurysm with hemopericardium; report of a case with healing. *New England J. Med.*, Jan., 1958, *258*, 116–

120. (From: The Department of Pathology, Los Angeles County Hospital, Los Angeles, Calif.)

Healing of a dissecting aneurysm of the aorta is not uncommon. It typically results in a "double aorta" with the aneurysmal sac originating and terminating in the original lumen. Obliteration of the lumen of the dissecting segment is rare.

Rupture into the pericardial sac is the most frequent cause of death in dissecting aneurysm. Death occurs by acute cardiac tamponade. Survival for five weeks has been the longest reported.

A case is presented in which a seventy-one year old male survived three months. Healing was accompanied by spontaneous resolution of the hemopericardium and union of the layers of the aorta by a vascular scar. Muscle loss rather than cystic medionecrosis was apparently the predisposing cause of dissection.

The amount of fluid in the pericardial sac necessary to produce cardiac tamponade depends on the volume and rate of accumulation. Studies on dogs suggest that venous pressure begins to rise when the volume of the fluid exceeds one third the weight of the heart or 80–100 ml. in humans. Effusions of 300 ml. or more are generally found in cases of fatal acute tamponade. Pericardial aspiration may be of therapeutic as well as diagnostic value in dissecting aneurysms, though it seems unlikely that aspiration alone will prevent further pericardial hemorrhage or extension of aortic dissection.—*Charles H. Helmen, M.D.*

Lund, Ronald R., Crisler, Eugene C., Sammons, Billy P., and Gartenlaub, Charles. Simultaneous occurrence of subcostosternal (Morgagni) hernia and hiatus hernia; report of a case. *Radiology*, April, 1958, *70*, 561–563. (Address: U. S. Naval Hospital, St. Albans, N. Y.)

The rare simultaneous occurrence of a subcostosternal (Morgagni) and a hiatal hernia is reported. This case is the second reported instance of this unusual combination of diaphragmatic hernias and is the only reported case where the herniations contained hollow viscera, permitting diagnosis of both hernias by barium contrast studies.

Diaphragmatic hernias are not unusual, particularly in persons over fifty years of age. Of the various types, the hiatal hernia is the most common, while the foramen of Morgagni hernia is the rarest of all forms of diaphragmatic hernia. However, both types have several common features: they are rare at birth; they usually occur in later life; they are more common in women; and they are the only types of diaphragmatic hernia with true hernial sacs.—*Edward B. Best, M.D.*

Abdomen

Bastide, R. (Lyon, France.) Contribution à l'étude radiologique des troubles de la déglutition chez le nourrisson et le jeune enfant. (Contribution to the radiologic study of swallowing difficulties in the infant and young child.) *J. de radiol., d'électrol. et de méd. nucléaire*, July-Aug., 1957, *38*, 663–674.

The author groups his cases as follows:

1. Swallowing Difficulties with Congenital Malformations: (a) *Bucco-labial-pharyngeal malformations.* These include labial dehiscence, macroglossia, cystic malformation at the base of the tongue, and particularly hare-lip, isolated or with a divided palate. In advanced cases suction and spoon feeding is impossible and when false alimentary passages into the air-way develop, the prognosis is grave. The ingestion of lipiodol demonstrates these passages and permits evaluation of "gavage" during surgery. (b) *Esophageal malformations.* These are primarily esophageal atresia with fistula formation between the digestive and respiratory tracts. Examination is done with lipiodol introduced through a catheter. Usually an esophageal obstruction is encountered so that the lipiodol ends in a cul-de-sac and perhaps a superior tracheo-esophageal fistula. Another type of fistula may develop inferiorly and sometimes both may be present, although the author includes one case with no fistula at all. The prognosis depends on how early the diagnosis is established and surgery performed. (c) *Hernia through the esophageal hiatus and malformations of the cardiac tuberosity of the stomach.* These anomalies contribute greatly to swallowing difficulties not only because the alimentary bolus is rejected, but because acid gastric juice bathes the lower end of the esophagus between meals. There are 3 major forms of hernia: partial gastric ectopy, paraesophageal, and sliding. In recent years the problem has been widened by the observation of minor signs of cardiac malposition, namely cardia mobile and cardio-esophageal relaxation. Paradoxically, large hernias may be asymptomatic except for pressure on the lungs while small hernias may be associated with hematemesis, peptic esophagitis or gastro-esophageal reflux. The roentgenologic examination consists of exposing a number of films during and after the ingestion of barium. This can be done during fluoroscopy or blindly, but fluoroscopy will determine the best positions. Relaxation of the "cardio-esophagus" is characterized by increase in the diameter of the inferior cardio-esophageal segment, loss of the angle of His and the ease of producing reflux. Cardia mobile is shown by the ascent of the cardia to the level of, then above the dome of the diaphragm. The cardia is so labile that it may reduce itself spontaneously during the examination. Reflux is produced easily. Careful attention should be paid to the lower esophagus for signs of peptic esophagitis, ulcer and true

stenosis. There may be contraction due to periesophageal fibrosis. Roentgenologic examination is also valuable postoperatively to detect recurrences which occur frequently.

2. Rare Causes of Swallowing Difficulty: Extrinsic compression as by hypertrophied thyroid, lymphadenopathy, pericarditis, right aortic arch, etc.

3. Functional Difficulties: Because of the danger of a false passage, lipiodol is used in the infant and liquid and barium biscuit in the young child to study these difficulties. They may be classified as: (a) *Buccal* with total absence of swallowing movement, or slowness of relaxation; (b) *pharyngeal* with partial, fragmentary or anarchic coordination of the pharyngeal musculature. Another sign is atony and stasis of the opaque material in the hypopharynx. The usual reflex closure of the nose and larynx may be lost; and (c) *esophageal*, a complete esophageal paralysis may be present, but more often there is a simple atony. The esophagus is large and movements lack efficiency and are disordered. This atony is almost always accompanied by hypertony of the cardia with true spasm.

The funtional difficulties in the young child may be the result of neurotropic infections, hypertension of the posterior fossa of the skull and psychogenic disorders. In the infant, prematurity, medication or encephalopathy may be incriminated.—*Marcy L. Sussman, M.D.*

WETTSTEIN, P. Le carrefour oesophago-gastrique chez le nourrisson et l'adulte. (The esophagogastric junction in the child and adult.) *Radiol. clin.*, Nov., 1957, *26*, 359–381. (From: Institute de Radiologie de la Clinique Générale de Genève, Geneva, Switzerland.)

A detailed discussion of the anatomy and physiology of the lower esophagus and the cardia is given as a prelude to the discussion of lesions in this region in children and adults. All infants who habitually vomit merit a careful roentgenologic study of this region. In infants it is necessary to distinguish malposition of the cardia and gastric fundus, large right diaphragmatic hernias and minor forms or syndromes caused by mobile cardia and chalasia of the esophagus. Reflux esophagitis may be a complicating feature in infants as well as in adults.

One may be tempted to think that dyspeptic symptoms in adults may be an extension of similar anatomo-physiologic dysfunctions about the lower esophagus and cardia, but it should be remembered that early cancer may be masked by similar roentgen findings.—*Charles M. Nice, Jr., M.D., Ph.D.*

KAUFMAN, S. A. Epiphrenic diverticula of the esophagus. *Am. J. Digest. Dis.*, Jan., 1958, *3*, 38–44. (Address: 750 Harrison Ave., Boston 18, Mass.)

Two types of diverticula of the distal esophagus are discussed. Symptoms, etiology, diagnosis, complications and treatment of pulsion diverticula are considered in detail with emphasis on the roentgen diagnosis. Five cases are presented.—*Jack Purcell, M.D.*

GORDON, SEWELL S. The angled postero-anterior projection of the stomach; an attempt at better visualization of the high transverse stomach. *Radiology*, Sept., 1957, *69*, 393–397. (Address: 54th St. & 48th Ave., S., Minneapolis 17, Minn.)

The high transverse stomach is difficult to examine, in most cases, with a resultant decrease in diagnostic accuracy. Part of this difficulty is due to body thickness alone, with subsequent poor fluoroscopic visualization, since this type stomach is found often in the obese patient. Other factors are involved which include inaccessibility of the stomach to palpation and, perhaps more important, the upper portion of the stomach is obscured because of considerable overlapping.

The author presents a preliminary report of an angled posteroanterior projection which was developed to minimize this overlapping of various portions of the stomach. The described procedure produces the effect of "opening-up" the stomach with the fundus and proximal segment projected upward with a relative downward projection of the antrum and distal segment. This view is obtained with upward or craniad angulation of the beam some 35° to 45°, centering on a 14 × 17 inch cassette placed beneath the chest with the upper edge of the cassette at the patient's chin. Additional technical factors are presented.

Three cases are reported to demonstrate the usefulness of this projection. Two cases were carcinoma of the proximal stomach wherein the extent of the lesions was demonstrated best on the angled projection. In the third case, a gastric ulcer of the lesser curvature at the incisura, the lesion was demonstrated only on the angled posteroanterior projection.

The author now routinely employs this technique on the high transverse stomach.—*Edward B. Best, M.D.*

VICKERS, JAMES E. Recurrent gastric ulcer incident to cortisone therapy. *Radiology*, Sept., 1957, *69*, 412–414. (Address: 999 San Bernardino Road, Upland, Calif.)

The occurrence of peptic ulceration of the stomach or duodenum in patients taking adreno-cortical substances is controversial. Some reports in the literature indicate that this is a possibility.

The author presents a case report of a patient who developed a very large gastric ulcer during cortisone therapy which promptly healed after discontinuance

of the drug. Upon resumption of cortisone the ulcer recurred, but healed again when the medication was stopped. The author feels that in this particular patient cortisone therapy was definitely related to the development of the gastric ulcer.—*Donald N. Dysart, M.D.*

GHISLANZONI, ROBERTO. La zona retrogastrica paramediana. (Paramedial retrogastric zone.) *Ann. radiol. diag.*, 1957, *30*, No. 4, 295–311. (From: Istituto de Radiologia della Università, Genova, Italy.)

With improved methods, investigation of the retrogastric zone has become more productive and accurate. Direct roentgenographic demonstration is always superior to indirect evidence and signs. Not only is the organ affected visualized, but also the pathologic changes.

The author presents 3 cases in which various procedures were used for proper study of the retrogastric zone. In Case I, a patient who had been subjected to subtotal gastric resection for ulcers of the stomach several years previously, jaundice and colicky epigastric pains were the outstanding symptoms. After a negative gastrointestinal series, precoccygeal air insufflation and laminagraphy revealed a mass in the region of the pancreas. At surgery, a pancreatic cyst containing 300 cc. fluid was found. In Case II, although the gastrointestinal series and retroperitoneal air studies gave evidence of a prevertebral mass, aortography demonstrated an aneurysm of the abdominal aorta. In Case III, a tumor mass located in the mesocolon was visualized by retroperitoneal air study and laminagraphy.

The conclusion is reached that in selected cases various studies, as utilized by the author, yield gratifying results in detecting pathologic lesions in the retrogastric zone.—*Peter E. Russo, M.D.*

NEWMAN, HARRY, and FRISCHE, LOUIS H. Lesser omental bursa abscess simulating gastric neoplasm; report of a case. *Radiology*, Oct., 1957, *69*, 567–570. (Address: H. Newman, University of Oregon Medical School, 3181 S. W. Sam Jackson Park Road, Portland 1, Ore.)

Abscess formation in any one of the subphrenic spaces may occur not too infrequently, but such a finding in the lesser omental sac or bursa is relatively rare. The authors report a case of such an abscess located in the lesser omental bursa. An upper gastrointestinal examination revealed a large mass protruding into the gastric fundus and pars media. The margins of this mass were smooth, sharply defined and curvilinear in contour, with no surface ulcerations being evident. The lesion appeared to arise from the posterior wall of the stomach and suggested the presence of a gastric neoplasm. At laparotomy a large mass was found in the lesser omental bursa, adherent to the posterior stomach wall and adjacent pancreas and spleen. While removing the mass, it was opened and found to be an abscess. The adherent stomach wall was removed with the mass. Microscopic examination showed no evidence of neoplasm.

Extragastric tumors may displace the stomach in any direction or cause compression resulting in a localized area of semi-translucency in the barium-filled stomach. The differential diagnosis should include adrenal, pancreatic, and renal neoplasms, aortic aneurysms, and omental cysts. In addition, the foramen of Winslow may become sealed by an inflammatory exudate, with fluid accumulation and distention of the lesser sac to such a degree as to cause gastric displacement or deformity, as occurred in this case.—*Donald N. Dysart, M.D.*

MEDHURST, GEOFFREY ARKILL. Duodeno-colic fistula. *Brit. J. Radiol.*, 1956, *29*, 381–385. (From: Department of Radiology, The United Sheffield Hospitals, Sheffield, England.)

Duodeno-colic fistula, whether produced by a malignant or a benign lesion, is a rare condition. The fistula more often follows involvement of the transverse colon and hepatic flexure by a malignant growth.

The symptoms may be those related to the underlying lesion with those of the fistula superimposed. If the condition is of long standing, the symptoms may be entirely due to the fistula. In the majority of cases, the fistula is best demonstrated by barium enema examination. Air contrast studies may give further information as to the track of the fistula. Barium meal and small bowel studies may sometimes reveal the fistulous communication but not the colonic lesion.

The author reports three additional cases of duodeno-colic fistula, including two new cases, two caused by carcinoma of the colon and one by a carcinoma of the gallbladder, which appears to be the first case reported.—*L. C. Lippert, M.D.*

DUBERGER, R. L. (Sherbrooke, Quebec, Canada.) Enterogenous cyst of the duodenum. *J. Canad. A. Radiologists*, Sept., 1957, *8*, 54–56.

The author reports an enterogenous cyst of the duodenum which communicated with the biliary tract. This was found in a girl fourteen years of age who had been having symptoms of epigastric pain and occasional vomiting dating back since early childhood. On physical examination a vague sensation of a mass was occasionally noted, but at other times this would disappear.

Roentgenographically, the descending duodenum was dilated and there was a smooth, rounded mass

below the ampulla. The mucosal pattern was not destroyed, but was spread out over the mass and the appearance was that of a benign intraparietal mass.

At surgery an egg-sized cyst was found which communicated with the bile duct.

The roentgenographic appearance was that of any intraparietal duodenal tumor, such as an adenoma or leiomyoma. Differentiation would be impossible unless it could be shown to vary in size at different times.

This is a rare condition, having been reported only 4 times previously—*George L. Sackett, Jr., M.D.*

Lans, Hyman S., Stein, Irving F., Jr., and Gumbiner, Bernard. Calcified appendiceal fecalith in a three year old child. *Quart. Bull., Northwestern Univ. M. School*, 1957, *31*, No. 4, 308–310. (From: The Departments of Surgery and Pediatrics, Northwestern University Medical School, and the Highland Park Hospital, Highland Park, Ill.)

A case is reported which, while not proved, is felt to represent a calcified fecalith in the appendix. On the admission of the patient to the hospital, a roentgenogram disclosed an ovoid calcific density in the right lower quadrant of the abdomen. An appendectomy performed "shortly after admission" revealed a gangrenous appendix, which was removed, but no fecalith could be palpated nor was such found when the appendix was subsequently examined.

Four days postoperatively, a roentgenogram of the abdomen disclosed the calcific density in the "region of the rectum." Two days subsequently a hard ovoid "foreign body" was passed with the feces and immediate roentgenographic examination of the abdomen failed to disclose the previously noted opacity.—*Fred Barlow, M.D.*

Bistolfi, Piero. L'impiego della simpamina nello studio radiologico delle condizioni spastiche della regione piloro-duodenale. (The use of simpamine in the radiologic study of spastic conditions of the pyloro-duodenal region.) *Radiol. med.*, June, 1958, *44*, 521–545. (From: Istituto di Radiologia della Università di Genova, Genova, Italy.)

The importance of early recognition of changes in the region of the pylorus and duodenal bulb cannot be overemphasized.

In the past, atropine, insulin, morphine, benzedrine sulfate and other drugs have been employed in order to better evaluate the suspected areas of the stomach or duodenum.

In this investigation the author has used a synthetic amine, simpamine. This drug has an action similar to ephedrine, producing, among other things, a relaxation of the smooth muscle of the alimentary canal.

The drug is given orally or intramuscularly and its dosage is 5 mg. and 10 mg., respectively. The effect on the stomach is observed between ten to thirty minutes from the injection and twenty to forty minutes from the oral intake.

The results obtained by the author confirm the findings noted by Smith and Chamberlin and Meyerson and Ritvo, who used benzedrine sulfate. The peristalsis of the stomach is essentially not modified by the drug and its only real effect is a relaxation of spasms of the pylorus and duodenal bulb and a decrease in the hypertonicity of the stomach when this is present.

Investigations on the effects of simpamine in other segments of the alimentary canal are planned and will be reported in the future.—*A. F. Govoni, M.D.*

Melamed, Myron, Steinberg, Leon H., and Pantone, Anton M. Infiltrating carcinoma of the stomach: Roentgen demonstration of the thickened stomach wall. *Radiology*, March, 1958, *70*, 404–407. (Address: M. Melamed, 1853 West Polk St., Chicago 12, Ill.)

A thickened stomach wall can be demonstrated in some cases of infiltrating carcinoma of the stomach. When the stomach is distended by barium, the inner contour is easily defined. The outer surface of the stomach can also be distinctly outlined at times because of the presence of overlying fat.

Two verified cases exhibiting this finding are presented.—*A. W. Sommer, M.D.*

Fossati, Franco, and Papagni, Leonardo. Aspetti radiologici della steatonecrosi parietale gastrica conseguente a pancreatite acuta. (Radiologic aspects of steatonecrosis of the gastric wall secondary to acute pancreatitis.) *Radiol. med.*, May, 1958, *44*, 407–414. (From: Istituto di Clinica Medica Gen. dell'Università di Milano, Milano, Italy.)

The authors report the case of a fifty-three year old man hospitalized with the clinical picture of an acute abdomen. Examination of the abdomen revealed tenderness and guarding in the left upper quadrant and a moderate distention. A history was obtained of gastrointestinal bleeding a few weeks earlier.

On the basis of an increased serum amylase, hyperglycemia, leukocytosis, marked anemia and melena, it was thought that the diagnosis of acute pancreatitis should be considered.

A roentgenologic examination of the upper gastrointestinal tract performed a few days after admission revealed many irregular filling defects in the body of the stomach, and, in particular, in the posterior wall. The mucosal folds appeared irregular and

coarse. These findings were constant and easily demonstrable in the prone position with only a small amount of barium coating the gastric walls. In the lateral projection the stomach was displaced anteriorly and the duodenal loop was somewhat widened with an irregular appearance of the mucosal folds. The emptying of the stomach was very slow; a scout roentgenogram of the abdomen taken a few days later showed traces of barium in the stomach. An elevation of the diaphragm with limited excursion and a left pleural effusion were also noted.

A repeat examination done two weeks later showed essentially the same changes and only a reduction in the amount of the left pleural effusion.

The condition of the patient improved somewhat, but a mass became palpable in the left upper quadrant of the abdomen. The mass was situated deeply and appeared to be oval, with an irregular surface and it was not very mobile.

The surgeons were not convinced by the clinical and roentgenologic findings and suggested the presence of an acute pancreatitis. An exploratory laparotomy was performed and demonstrated a resolution of an acute hemorrhagic pancreatitis with fat necrosis involving the peritoneum, the omentum, the posterior part of the fundus and the body of the stomach.

The condition of the patient continued to improve and he was discharged.

A recheck of the stomach a year later showed a normal appearance of the gastric walls and mucosa, with a normal morphology of the duodenal loop.

The necrosis of the gastric wall is apparently due to the action of the pancreatic ferments, diffused from the gland, and is revealed roentgenologically by filling defects and irregularities of the gastric mucosa of the part involved.

In the opinion of the authors this is the first case of acute pancreatitis with such involvement to be reported.—*A. F. Govoni, M.D.*

Hope, John W., and O'Hara, A. Edward. Use of air as a contrast medium in the diagnosis of intestinal obstruction of the newborn. *Radiology*, March, 1958, *70*, 349–361. (Address: J. W. Hope, 1740 Bainbridge St., Philadelphia 46, Pa.)

High intestinal obstruction in the newborn infant is a surgical emergency which requires early, accurate diagnosis. The infants so affected often have a single correctable abnormality, but any undue delay in diagnosis markedly reduces their chances of operative survival. The authors specifically condemn unnecessary roentgenologic procedures which not only may delay and obscure the diagnosis but also produce unnecessary radiation exposure. Of the procedures available, fluoroscopy is the least diagnostic while producing the greatest amount of radiation hazard. As an example, five minutes of fluoroscopy (55 kv., 3 ma., 2 mm. Al) on an average infant of 10 cm. thickness will result in 23 r to the skin and 6.1 r to the mid abdomen. In contrast, a total of five so-called "plain" roentgenograms of the abdomen will produce, both by calculation and measurement, only 0.315 r to the skin and 0.098 r to the mid abdomen (50 kv., 400 ma., 1/40 sec., 36 inch dist., 1 mm. Al).

Air is the most useful of all contrast media in the examination of the infant gastrointestinal tract, particularly in cases of high intestinal obstruction. Opaque media are to be avoided as they merely puddle in the bowel and confuse the examiner, thereby delaying diagnosis. In cases of low intestinal obstruction, where many dilated loops are present a barium enema only is advised in order to identify the colon.

The appearance of the dilated air-containing stomach and small bowel proximal to a high obstruction is characteristic and, with experience, one can give an accurate diagnosis with only 2 roentgenograms of the abdomen: a recumbent and an upright roentgenogram. If little or no air is present, a portion of the gastric contents can be carefully withdrawn through a soft rubber catheter and replaced with an equal volume of air. The ease of diagnosis with air as a contrast medium is illustrated in cases of duodenal obstruction due to annular pancreas, atresia, and congenital bands, and in cases of jejunal and ileal obstruction.—*Edward B. Best, M.D.*

Kleppel, Bernard. Congenital enteric duplication cyst; report of a case diagnosed roentgenologically. *Radiology*, April, 1958, *70*, 570–573. (Address: Michael Reese Hospital, Chicago 16, Ill.)

A case of enteric duplication cyst occurring in a three-year-old male is presented. Severe abdominal pain, vomiting and massive rectal bleeding were the presenting signs and symptoms. Small bowel barium studies revealed a spherical pouch about 6 cm. in diameter communicating with the small bowel. Unusual mucosal folds in this pouch resembled gastric rugae. The diagnosis of Meckel's diverticulum or duplication cyst was made on the basis of these roentgen findings. A segment of small bowel with the attached duplication cyst was excised. The cyst measured 6 cm. in diameter and was lined with gastric mucosa containing focal areas of hemorrhage.

Congenital bowel diverticula are of two types: (1) Meckel's diverticula, the remnants of the vitelline duct, which may contain ectopic gastric mucosa and (2) intestinal duplications, which are described as spherical or elongated hollow structures which possess a coat of smooth muscle, are lined by a mucous membrane similar to some part of the alimentary canal, and are intimately attached to some part of the alimentary tube. These may be found at any point along the gastrointestinal tract but are most common in the ileum along its mesenteric border. In 55 of 68 cases studied by Gross, Holcomb and

Farber, there was no communication with the lumen of the adjacent gut. It is extremely difficult to try to differentiate roentgenologically between a Meckel's diverticulum and a duplication cyst, so that for the purposes of reporting, the general designation of congenital small bowel diverticulum should be used.—*Z. Petrany, M.D.*

Goldenberg, Ira S., and Hayes, Mark A. Postobstructive small bowel dyskinesia. *Ann. Surg.*, Jan., 1958, *147*, 26–32. (From The Department of Surgery, Yale University School of Medicine and the Yale-New Haven Medical Center, New Haven, Conn.)

The authors report on a series of 96 patients operated upon for benign small bowel obstruction of which 9 displayed an abnormal postoperative bowel recovery phase. This was manifested clinically by abdominal distention of some magnitude with normal audible peristalsis and daily bowel evacuations in the presence of normal appetite and oral ingestion of food. Roentgenographic evaluation of the abdomen usually revealed distended loops of small bowel resembling mechanical obstruction or ileus.

This syndrome can be disturbing because of the lack of correlation between the diverse factors of distention, normal peristalsis, oral intake of food, bowel evacuation and the roentgenologic findings consistent with small bowel obstruction or ileus including gas filled loops of bowel with fluid levels.

Three of the 9 cases are reported in some detail with illustrations. The authors state that local tissue alterations are responsible for the syndrome that they describe. They postulate that a temporary dyskinesia is present, the usually coordinated bowel activities of peristalsis, segmentation, and pendulation being out of phase. Material is passed through the bowel lumen, but the bowel is not completely cleared of contained gas and feces.

Recognition of the syndrome is important so that long intubation of the small bowel as well as stimulation with drugs can be avoided. Neither is indicated and each may be harmful. The syndrome is self-limited and needs no specific therapy.—*Roscoe E. Miller, M.D.*

Acosta, Juan M., and Ravenna, Hector. Vesicula calcificada. (Calcified gallbladder.) *Prensa méd. argent.*, Dec. 13, 1957, *44*, 3611–3614. (Address: J. M. Acosta, Santa Fe, 4442 Rosario, Santa Fe, Argentina.)

Two cases of calcified gallbladder are fully described and illustrated with roentgenographic reproductions and photomicrographs. Cholecystograms showed a nonfunctioning gallbladder, but in both instances an oval mass could be observed in the right upper quadrant with peripheral calcification and a dense shadow in the center. The surgical specimens revealed the typical changes of chronic cholecystitis with profuse deposits of calcium and large calcific calculi. Spotty calcification of the gallbladder wall in chronic cholecystitis is of fairly frequent occurrence, although such a massive layering of calcium has been reported only in a few sporadic communications. It is thought to merely represent an extreme case of a common pathologic process, *i.e.*, calcification in sites of chronic inflammation, without having to invoke considerations of hormonal imbalance. In the cases reported, serum calcium, phosphorus, and alkaline phosphatase were normal.—*Francisco Comas, M.D.*

Fraser, Robert G., Peirce, Carleton B., and Fitzgerald, Patrick J. Polypoid cholesterolosis of the gallbladder: A clinical and radiological evaluation. *J. Canad. A. Radiologists*, June, 1958, *9*, 15–25. (From: The Department of Radiology, Royal Victoria Hospital, Montreal, Canada.)

The roentgenologic diagnosis of disease of the gallbladder, perhaps more than any other organ of the body, has been perfected to such a degree that its dependability and accuracy are almost beyond any reasonable doubt. This accuracy, which must be well over 95 per cent, has developed for 2 obvious reasons: First, the ease with which the gallbladder may be opacified by relatively nontoxic media and; secondly, its ready accessibility to roentgenologic exploration.

It is conceivable, however, that this knowledge has had the adverse effect of having lulled radiologists and other clinicians equally into a false sense of security. For example, prior to 1955, the diagnosis rendered on the 23 cases of cholesterol polyposis forming the subject matter of this paper would doubtless have been "cholelithiasis in a normally functioning gallbladder." The authors propose, therefore, to demonstrate that cholesterolosis, in a considerable proportion of cases, is a roentgenologically diagnosable disease and that it merits recognition as a potential symptom-producing lesion.

Cholesterolosis is a common pathologic entity characterized by an accumulation of abnormal amounts of lipoid, chiefly cholesterol and cholesterol ester, in the gallbladder wall. The deposits are predominantly intracellular, partly in the mucosal histiocytes which clump together as foam cells. The amount of lipoid deposited varies markedly in degree, producing all gradations from mild speckling to a stage where the accumulation assumes such proportions as to create large polypoid masses protruding into the gallbladder lumen.

It is when the local accumulation of lipoid is sufficiently large to distend the villi to polypoidal proportions that cholesterolosis becomes a roentgenologically significant disease, and it is this group which forms the subject matter of this paper.

Cholesterolosis, whether occurring alone, or in association with cholecystitis or cholelithiasis is not an uncommon condition. In 10 large surgical and autopsy series, its average incidence was 23 per cent of all pathologic gallbladders. Excluding from this total those gallbladders showing only diffuse cholesterol infiltration—the typical "strawberry" change—as well as those with cholelithiasis or a major degree of cholecystitis, there are left a relatively small but significant number of cases in which a local superabundance of cholesterol has accumulated in the form of polypi.

The symptomatology of cholesterolosis, whether of the diffuse or polypoid variety, differs in no fundamental respects from that of chronic cholecystitis or cholelithiasis. The fact that differentiation on clinical grounds is never really possible is clearly in evidence in several reviews of the subject that have appeared in the literature.

The roentgen manifestations of cholesterol polyposis are, as might be imagined, the result of the gross appearance of the mucosal surface of the opened gallbladder. What would otherwise be regarded as a perfectly normal mucosa is studded with several pedunculated masses varying from 3 to 10 mm. in diameter. Although occasionally solitary, they are almost always multiple. Characteristically, they are more numerous in the upper portions of the body and infundibulum than in the fundus.

It is easy to understand how the normally smooth, sharply delineated contour of the healthy gallbladder, as seen cholecystographically, could be deformed by such lesions. Protruding into the dye-filled lumen are defects of varying size, almost always discrete but occasionally confluent. Their contour is irregular and commonly less sharply defined than calculi. In contrast to calculi they remain constant in site, whether the patient be examined in the erect or supine position. Visualization in profile is important, especially in the study of small polyps since, in further contrast to calculi, no dye-containing bile will separate the lesion from the wall. Visibility of small polypi is always enhanced following the partial emptying of the gallbladder in response to a fat meal. It need hardly be stressed that compression studies in the erect and supine positions under fluoroscopic control are a *sine qua non* of adequate diagnosis. It has been our observation that the concentrating power of the mucosa is not only maintained, but is in many cases greater than average, with the result that the density of the gallbladder shadow is striking. A similar and equally frequent observation is the apparent increased degree to which the gallbladder empties in response to fat.

The differential diagnosis of cholesterolosis includes only 3 conditions of any significance. Radiolucent calculi are almost never constant in position, varying with change in posture and frequently "layering" in the upright position. Stones always will show a thin layer of contrast medium separating them from the gallbladder wall. True benign papillomata and cholesterol polyps are difficult to differentiate roentgenologically. Only when they are single, under which circumstances they are frequently fundal in position, may the diagnostic stress be placed on papilloma. On occasion, inflammation of the gallbladder wall gives rise to a local active proliferation and hyperplasia of the mucosal epithelium so as to produce a papillomatous outpouching from the mucosa. The descriptive term "cholecystitis glandularis proliferans" was applied to this lesion. By dint of being almost always solitary and possessed of a broad sessile base, it should offer little difficulty in differentiation from cholesterol polyposis, but seldom can be differentiated preoperatively from true neoplastic papilloma.

Cholecystectomy is the treatment of choice in 2 groups of patients: those who present with a history of biliary colic; and those in whom differentiation from multiple papillomata and therefore possible malignancy is impossible. Patients whose symptoms tend to be vague and ill-defined do not as a rule benefit from cholecystectomy.

The authors present 23 cases of cholesterol polyposis. This is an excellent paper and should be read in its entirety by all radiologist.—*William C. Mac Carty, Jr., M.D.*

Gynecology and Obstetrics

Parlee, Stephen S. Radiation hazards in obstetrics and gynecology. *Am. J. Obst. & Gynec.*, Feb., 1958, *75*, 327–333. (From: The Department of Obstetrics and Gynecology, University of Alberta School of Medicine, Edmonton, Alberta, Canada.)

The obstetrician is concerned with 2 effects of ionizing radiation on his patients, first, the whole body or somatic effect and, second, the effect on the gonads and the consequent effect on heredity. The average radiation from natural background sources to citizens in the United States during thirty years of genetic lifetime is 3 r, with a range of 5 to 15 r. About 0.1 r of this is from atomic bomb fallout. The average background dosage is increased from 2 to 4 r by diagnostic roentgen rays in the first thirty-five years of life.

Therapeutic doses of radiation in the first trimester of pregnancy will cause fetal death or malformations of the central nervous system, and such a circumstance is ample grounds for interruption of pregnancy. Stewart of England reported that a child born of a woman who received diagnostic irradiation to her pelvis is twice as likely to develop leukemia as a child born of a woman not so irradiated. Such a cause and effect relationship has not been established.

There is irrefutable evidence that radiation causes gene mutations, and these are of significance when

they involve reproductive cells. The rate of mutation varies directly with the amount of radiation received by the gonads. Such mutations reduce the survival rate of the species. In man it appears that the spontaneous mutation rate is already as high as his reproductive capacity can tolerate or even higher, and this is particularly true now since medical salvage of cases afflicted with harmful recessive mutants alters the natural extinction process.

Mutants appear and disappear at the rate of about 0.2 per generation. It takes about 40 generations for a mutation to die out, and these mutations are being reintroduced at about the same rate. Geneticists feel therefore, that if sufficient radiation is given to double the mutation rate, this dosage is alarming. The most acceptable figure for this doubling dose is about 80 r. The effect of 80 r on 10 per cent of the population is the same as 8.0 r on 100 per cent. If a doubling dose were given to the whole population, the first generation would have 8.2 mutants, not 16, since we are doubling the rate and not the number of mutants. This would mean 1 in 200 genetic deaths in the next generation, or 750,000 in a population of 150,000,000 and 30,000,000 out of 150,000,000 in the next generation would survive and reproduce with detrimental genes. In 40 generations there would be 16 detrimental genes instead of 8, and up to 2/5 of all conceptions would end in less of reproductive capacity, and large number of survivors would be severely handicapped. This is the long term effect of doubling the mutation rate and could mean the extinction of the human race.

Although every roentgenogram to which an obstetric patient is subjected increases the mutation rate, only therapy directed to the ovaries for sterility approaches a doubling dose. Gonadal exposure can be reduced chiefly by reducing the size of the irradiated field and by shielding. The use of roentgenograms of the pelvic area as well as the use of radioisotopes should be avoided whenever possible in women in their reproductive years. The indications for roentgenographic study of the pregnant woman should be more stringent, particularly in the earlier months of pregnancy. Pelvimetry should be done only for good indications and preferably during labor. The Thom's inlet view should be discarded because it delivers as much as 2.5 r to the gonads. The most valuable view is a standing lateral because the fetal gonad receives only scattered radiation. Roentgenograms should not be repeated just because they are not quite perfect. Consideration should be given to the elimination of roentgen diagnosis of placenta previa. This diagnosis is almost invariably made by vaginal examination.—*John A. Campbell, M.D.*

Genitourinary System

Meldolesi, Gastone. Quadri angiografici fortemente ingranditi nel rene anurico (per legatura dell'uretere); (Studio sperimentale). (Greatly enlarged angiographic images of the anuric kidney [following ligation of the uteter]; [experimental study].) *Radiol. med.*, June, 1958, *44*, 497–520. (From: Istituto di Radiologia della Università di Catania, Catania, Italy.)

The changes on the vascular anatomy of the kidneys of dogs, following the ligation of one or both ureters, have been investigated by micro-arteriography.

For these investigations, the author followed essentially the technique adopted by Barclay in his studies on micro-arteriography of the normal kidney (Am. J. Roentgenol. & Rad. Therapy, July, 1948, *60*, 1–12).

One or both ureters were ligated for periods of from three to forty-eight hours. The contrast medium, a radiopaque plastic substance, was then injected into the renal artery and the kidney excised.

The data obtained up to the present time show that the arterial damage results from more or less severe spasms in the arterial bed, involving in the beginning only a few segments and then the whole kidney. There follows the occlusion of only the smaller intralobular arteries and after a longer period of time, the occlusion of larger arteries with the formation of arteriovenous shunts between the intralobular arteries and veins. In the end the main arteries are also occluded and the blood, therefore, no longer reaches the intralobular arteries and the arteriovenous shunts.

The ligation of one ureter for a certain period of time produces an arterial damage in the kidney involved which is less severe than in the case when both ureters are ligated for the same length of time.

If the ligation of one ureter is prolonged, the arterial damage produced in the kidney involved appears to be of the same severity as in the case of the ligation of both ureters for a shorter period of time. There is, however, a certain qualitative difference between the alterations resulting from the 2 procedures.

It is interesting to note that the kidney not in prerenal anuria also will show arterial damages, more or less severe, depending on the period of time the ureter of the opposite kidney was ligated.

The article is illustrated with reproductions showing the different vascular changes as demonstrated by the micro-arteriography technique.—*A. F. Govoni, M.D.*

Carnevali, G., Catania, V. C., and Di Pietro, S. Contributo radio-chirurgico allo studio dei surreni mediante pneumoretroperitoneo. (Contribution on the radiological surgical study of the suprarenals by retropneumoperitoneum.) *Ann. radiol. diag.*, 1958, *30*, No. 6, 466–489. (From: Istituto di

Radiologia della Università di Milano, Milano, Italy.)

For the cases in this study, the authors used patients with advanced cancer of the breast who were subjected to adrenalectomy. This method permitted them to study patients with normal adrenal glands as well as patients with primary and secondary tumors of the adrenals. Laminagraphy was utilized to supplement conventional roentgenographic studies.

Since all of these cases came to surgical exploration, the authors attempted to resolve certain problems concerning the value of this method of examination.

The first problem studied was the method of diffusion of the gas in the perirenal and suprarenal spaces. They found that because of the closer confines of the suprarenal area and the greater density of the fat, the gas has more difficulty in diffusing into the tissues of the suprarenal than of the perirenal spaces. For this reason, the adrenal glands may not be clearly outlined on routine roentgenograms, and laminagrams may be necessary.

The second point brought forth by this study is the fact that due to the normal variations in size and position of the adrenal glands, their atrophy or hypertrophy cannot be determined by this method.

In primary and secondary neoplastic diseases of the adrenals, this method finds its greatest usefulness. The adrenal gland not only becomes enlarged, but loses its characteristic triangular shape. Air may fail to diffuse into the supporting structures due to infiltration by the malignant process.

This report is of great interest because of the surgical correlation which often followed the air studies only by a few hours. The authors also emphasize the fact that interpretation of air studies presents several problems and that further studies in this field are necessary.—*Peter E. Russo, M.D.*

SKELETAL SYSTEM

BROWN, NORMAN M. Localized osteochondritis of the spine. *J. Canad. A. Radiologists*, June, 1958, *9*, 26–31. (Address: Drummond Medical Building, 1414 Drummond St., Montreal, Quebec.)

Osteochondritis of the dorsal spine (Scheuermann's disease) presents a characteristic and widely recognized clinical and roentgenologic appearance. In this condition the roentgen-ray changes seen are so typical that they are not likely to be mistaken for any other condition.

The localized form of the disease, however, usually involves only one or two vertebrae and, therefore, is less well known. It occurs in the dorsolumbar region. Its roentgenologic appearance very frequently leads to an erroneous diagnosis of tuberculosis of the spine.

Osteochondritis affecting the dorsal spine was first recognized in 1921, and was found to produce symptoms in young persons between the ages of twelve and seventeen. Both sexes are equally affected. In this condition there is kyphosis associated with fragmentation of the epiphyseal ring, progressive narrowing of the intervertebral disk space, deep irregularities on the edges of the vertebral bodies, Schmorl's nodes and anterior wedging of the vertebrae. Scheuermann called the condition kyphosis deformans juvenilis, believing it to be osteochondritis and therefore similar in etiology to Perthes' disease in the femur and Kohler's disease of the tarsal scaphoid bone.

Localized osteochondritis of the spine is a condition which seems to be of the same nature as Scheuermann's disease. Hafner in 1952 described 4 cases. In 1945 Lamb reported 7 additional carefully documented cases. Lamb's hypothesis concerning the characteristic anterior defect is as follows: There is weakness of the disk, either congenital or posttraumatic. As the fluid nuclear material escapes, the disk space narrows. The fluid material may break the cartilage plate to form Schmorl's nodes, but may exert pressure anteriorly. The anterior longitudinal ligament resists this force, which is directed onto the upper or lower corner of the vertebral body. There is consequent pressure necrosis of bone and formation of the characteristic defect.

Differential diagnosis from tuberculosis is important. The following are significant factors in the differential diagnosis: (1) There is no paravertebral abscess formation; (2) the vertebral defect has a characteristic "punched out" appearance; (3) Schmorl's nodes or other evidence of vertebral epiphysitis may be present in other vertebrae; (4) the Mantoux test is often negative; and (5) the sedimentation rate, differential blood cell count, and chest roentgenogram are normal.

Two cases of localized osteochondritis of the spine are described in detail, together with a third case showing a lumbar body lesion associated with lower dorsal lesions.—*William C. MacCarty, Jr.*

LE MAY, MARJORIE. The early radiological diagnosis of osteomalacia in adults. *Radiology*, March, 1958, *70*, 373–378. (From: Boston VA Hospital, Boston 30, Mass.)

Osteomalacia is an abnormality of bone metabolism characterized by an inability of the body to lay down mineral salts upon the bone matrix. It may be due to lack of calcium in the diet, interference with the absorption of calcium from the intestinal tract, or abnormal mobilization of calcium or phosphorus from the body. The usual blood findings in osteomalacia are a uniformly low phosphorus, a normal or low calcium, and a slightly increased alkaline phosphatase.

The first roentgenologic sign of osteomalacia in an adult is a radiolucent line in one or more bones subjected to chronic, mild trauma. The usual sites for early lesions are the neck of the femur, the pubic

bones and the lateral border of the scapula. There is a definite correlation of the sites of these symmetric lesions with the location of blood vessels in the bone. The radiolucent zones are usually called pseudofractures, or Umbauzonen of Looser. Early in the process the bones elsewhere will appear normally mineralized. Later all bones will show poor mineralization. In advanced cases true fractures may occur through the radiolucent zones, and the vertebral bodies may show biconcave deformities and compression fractures.

Osteomalacia is most commonly confused with osteoporosis. The basic defect in osteoporosis is a lack of bone matrix. Pseudofractures do not occur. Roentgenograms show the bones to be poorly mineralized. The trabecular pattern of the vertebral bodies is poorly seen, and their denser superior and inferior margins contrast sharply with the rest of the vertebra.

Roentgenograms of 3 cases demonstrating characteristic lesions are included.—*Arno W. Sommer, M.D.*

Hulth, Anders. The vessel anatomy of the upper femur end with special regard to the mechanism of origin of different vascular disorders. *Acta orthop. Scandinav.*, 1958, *27*, No., 3, 192–209. (From: The Surgical and the Orthopedic Department, University of Uppsala, Uppsala, Sweden.)

Attempts to explain the causes of the different vascular disorders of the upper end of the femur have lead to a great deal of study of the vessel anatomy of the femur. A large part of the upper end of the femur is intra-articular, making its vasculature vulnerable. The vessels supplying the head and neck of the femur are the medial femoral circumflex artery and the obturator artery. The latter travels via the ligamentum teres, while the former courses on the dorsal side of the base of the neck. The branches of the medial circumflex artery run within the joint in synovial reflections called retinacula. There is a major superior retinaculum and a smaller one on the inferior edge of the femoral neck.

The arteries and veins of both major sources of blood run close together and parallel with one another. This has made it possible to study blood supply by the intra-osseous venographic method. Technique of intra-osseous venography of the head is described. Positive venographies are those with contrast filled veins, while negative venographies indicate avascular head fragments. The better prognosis of the undisplaced valgus type femoral neck fractures is shown to be due to better retained vascularity from the retinacular vessels. Displacement is a most important cause of vessel damage.

Hip disorders in children are discussed. No vessels pierce the epiphyseal plate. Vessels to the epiphysis and metaphysis pass within the joint. Blood supply via ligamentum teres does not develop before the age of eleven years. These data are considered in theorizing about the genesis of slipped epiphysis and Legg-Perthes disease.—*Richard E. Kinzer, M.D.*

Freiberger, Robert H. Multiple epiphyseal dysplasia; a report of three cases. *Radiology*, March, 1958, *70*, 379–385. (Address: 535 East 70th St., New York 21, N. Y.)

Multiple epiphyseal dysplasia is a rare congenital growth disturbance which affects symmetrically all or some of the epiphyses of the skeleton and the primary ossification centers of the tarsals and carpals. The spine remains normal in most of the cases, but changes, when present, may somewhat resemble the vertebral abnormalities seen in Morquio's disease. It is important to differentiate multiple epiphyseal dysplasia from Morquio's disease, achondroplasia, and bilateral Legg-Perthes disease because of the good prognosis of this condition as to crippling, and the fact that no treatment other than osteotomy for correction of long bone deformities is required. Prognosis as to intelligence, life expectancy and range of activity is good.

Clinically the disease becomes evident in childhood after the onset of walking when a disturbance in locomotion, genu varum or valgum deformities, or severe flatfoot become apparent. The roentgenographic characteristic is a symmetric involvement of several epiphyses and primary ossification centers of the carpals and tarsals. The epiphyses have markedly irregular outlines and they may be fragmented or stippled. These changes are those of abnormal ossification and growth of cartilage and not those of avascular necrosis. The ossification centers are smaller than normal. Metaphyseal irregularity may also be present with tibial bowing and either knock-knee or bowleg deformity being common.

The course of the disease appears to be static in childhood with a tendency toward a more normal roentgenographic appearance of the epiphyses toward the end of the growth period. The author presents 3 cases illustrating these findings.—*Donald N. Dysart, M.D.*

General

Felson, Benjamin, and Braunstein, Herbert. Noninfectious necrotizing granulomatosis; Wegener's syndrome, lethal granuloma, and allergic angiitis and granulomatosis. *Radiology*, March, 1958, *70*, 326–334. (From: Cincinnati General Hospital, Cincinnati 29, Ohio.)

The disease entities known as Wegener's syndrome, lethal granulomas, and allergic angiitis and granulomatosis are related entities and are included by the authors under the generic term noninfectious necrotizing granulomatosis. Clinically the most common systemic manifestations are fever, weight loss,

weakness, anemia and leukocytosis. Superficial ulceration soon progressing to severe destruction of bone and cartilage often occurs in the nose, nasal mucosa, palate, oral cavity, paranasal sinuses, nasopharynx and other upper respiratory structures. When the lungs are involved, chest pain, cough, hemoptysis, night sweats and dyspnea are common. Evidence of renal involvement may be present as well as indolent ulcerations of the skin. Clinical manifestations referable to the nervous system, myocardium, bones and joints, and gastrointestinal tract are not uncommon since practically any organ of the body may be affected.

The roentgen findings depend on the location and severity of the involvement. Extensive sinusitis or destruction of segments of the facial skeleton may be demonstrated when the facial structures are involved. The chest roentgen findings are quite diverse and nonspecific. Bronchopneumonia, congestion and edema, pulmonary infarction or pleural fluid may be present. One chest finding, that of solitary or multiple nodules or infiltrates, chronic in nature, with central cavitation is suggestive of the diagnosis especially if associated with the clinical manifestations.

The differential diagnosis should include malignant neoplasm, specific granulomas such as tuberculosis, syphilis, fungus disease and leprosy. Pemphigus, erythema multiforme, agranulocytosis and Vincent's angina must also be considered. Periarteritis nodosa may cause pulmonary changes identical to those seen in necrotizing granulomatosis. Loeffler's pneumonia usually has a relatively shorter clinical course.

The diagnosis, therefore, depends on the presence of several of the following manifestations: allergic background, destructive granulomatous lesions of the facial and upper respiratory structures, skin granulomas, eosinophilia, renal disease and the previously described roentgen findings. Six cases are presented, 2 in detail—*Donald N. Dysart, M.D.*

Meszaros, William T. The regional manifestations of scleroderma. *Radiology*, March, 1958, *70*, 313–325. (From: Department of Radiology, Cook County Hospital, Chicago, Ill.)

Scleroderma is one of the "collagen" diseases with extensive manifestations affecting multiple organs. It is characterized by primary changes in the collagen proper. Initially there is edema of the collagenous intercellular tissue, followed by induration and thickening. Vascular changes are prominent; eventually parenchymal atrophy occurs. Visceral changes are present more often than is apparent clinically. Complete roentgenologic studies are, therefore, indicated in all patients with scleroderma.

Absorption of the distal phalanges is one of the most characteristic roentgen findings. In severe cases absorption may be observed in the middle and proximal phalanges. Rarely, absorption of the carpal bones and the distal ends of the ulna and radius may occur. Calcified deposits in the soft tissues are often noted. Dysphagia is the most common esophageal symptom. The esophagus is widened and atonic, with little or no evidence of peristalsis. The entire esophagus may be involved but findings are usually more pronounced in the lower portion. If the patient is examined in the upright position, the dilatation may not be apparent, because of rapid emptying by the effect of gravity. Examination in the recumbent position discloses the dilatation and lack of tone. The mucosal pattern of the esophagus is often poorly defined. Esophagitis with associated narrowing, irregularity, and ulceration is not uncommon. The stomach and duodenum and frequently the jejunum may be dilated and atonic. At times the dilatation of the small bowel may be so marked as to suggest paralytic ileus or even organic obstruction. The colon may also be dilated and atonic. Roentgenograms of the chest may reveal generalized cardiac enlargement, and a diffuse pulmonary fibrosis. The fibrosis is most marked in the lower lung fields, but may involve the upper and middle portions as well. Cystic changes may be present.

Knowledge of all possible manifestations is important to the radiologist, who may be the first to suggest the correct diagnosis.—*Anro W. Sommer, M.D.*

Housepian, Edgar M. A biplane grid utilizing a common horizontal plane for localization of radiographic landmarks in two conventional roentgen views. *Radiology*, March, 1958, *70*, 398–400. (Address: 622 West 168th St., New York 32, N.Y.)

The author describes and illustrates a biplane gridded cassette holder which utilizes a common horizontal reference plane for both the anteroposterior and lateral roentgenogram. Such an arrangement allows accurate localization of landmarks usually identified in a single roentgen view.

This unique device is an adaptation of a method developed for neurosurgical use in localizing the globus pallidus in relation to the anterior commisure. The author recommends that 2 roentgenographic machines be positioned and aligned in relation to the 2 cassettes. This instrumentation not only allows control for obtaining truly serial roentgenograms for stereotaxic procedures, but also conserves operating time during certain surgical procedures.—*Edward B. Best, M.D.*

Bonann, Louis J., and Dowdy, Andrew H. LogEtronic simplification in simulated color radiography. *Radiology*, April, 1958, *70*, 585–587. (Address: L. J. Bonann, University of California Medical Center, Los Angeles 24, Calif.)

Simulated color radiography with the use of "color roentgenograms" is of value in the teaching of anatomy, especially in the field of correlation of anatomic relationships. The success of the final color preparations depends primarily on the quality of the original negative as it must contain and transmit all of the definition desired for the proper form and value of the color film.

The authors describe a technique utilizing the LogEtronic procedure which reproduces accurately at midscale the most useful portions of the density range of the negative. The opposite extremes of the density scale are "dodged" by this process which approximates them to an average density. This permits a reduction of the gross contrast while detail contrast is increased, resulting in better reproduction and improved visualization. The exact operation of the LogEtron is almost automatic and is described fully, step by step in the instruction manual. The procedure followed in this technique is described.—*Donald N. Dysart, M.D.*

RADIATION THERAPY

LOVE, JESSHILL, and MATTHIS, CHARLES W., JR. Superficial x-ray therapy. *South. M. J.*, July, 1958, *51*, 884–888. (From: The Department of Radiotherapy, St. Joseph Infirmary, and the Department of Physics, University of Louisville, Louisville, Ky.)

A brief review of a few of the important fundamentals of superficial roentgen therapy was made by re-examining the physical characteristics of a low voltage beam.

Commercial cones furnished by the manufacturer carry no assurance that the central beam passes through the center of the cylinder. A pinhole photograph of the focal spot will determine its position in the field at the distal end of the cone. A central image of the focal spot ensures equalized distribution of the beam in the absorbing media.

Isodose readings on the surface of a phantom, even with an eccentric central beam, demonstrate a fairly homogeneous and predictable distribution of energy. Similar readings in a cross section of the beam in air tend to follow the geometry of the photons reflected from the surface of the anode and the shape of the focal spot. Changes in the shape and position of the focal spot are observed in the pinhole photographs with changes in the current.

The quality of the low energy beam is defined by its absorption in layers of aluminum. The absorption curve tends to become linear as the beam approaches a higher quality and successive half-value layers approach a single value.

Surface dose readings are increased 8 to 10 per cent when lead foil is used on the skin rather than apertures in the base plate to define the treatment portal. This is due to backscatter from both the lead foil and the transmitted dose. Small field dose calculations should therefore be based on the number of centimeters of exposed area, plus backscatter, and should not be given as a statement of air dose.

The predicted air dose rate for the low energy beam is changed very little by backscatter from the phantom as shown experimentally, but the backscatter increases as the quality of the radiation improves and a significant discrepancy between the estimated and recorded doses results at the higher energies.

A comparison of a beam's absorption curve in tissue and in some media like pressdwood gives a practical indication of the beam's quality as it will cross at about the half-value layer of the phantom. This is true because the phantom is homogeneous in a density said to represent the "average" specific gravity of the body.

Depth dose was shown to increase with an increase in field or cone size, all other factors being constant.

Volume doses to the half-value layer when comparing small and large field sizes may vary by a factor of 50 when a comparison of the air doses shows only a factor difference of 1.3. This becomes of practical importance in dermatologic conditions where small fractionated doses given over a period of time through large portals may build up a volume dose of several hundred thousand roentgens as evidenced by the late development of skin atrophy and telangiectasia.—*Donald M. Monson, M.D.*

BÁRON, JULIUS G. True tangential x-ray treatment of small skin lesions. *Radiology*, May, 1958, *70*, 746–748. (Address: VA Hospital, Iowa City, Iowa.)

In the treatment of benign skin lesions, it is desirable to avoid as much as possible irradiation of the adjacent normal tissue. In patients with protruding skin lesions, this can be achieved by the use of tangential exposures. However, many skin lesions are not prominent enough for the use of tangential ports. For treatment of lesions level with the skin surface, the author describes a brass cone 4×4 cm., 37 cm. long, which has an opening along one side near the distal end through which the skin can be sucked up with the use of negative pressure into the path of the roentgen rays. The distal end of the cone is closed with lead and the cone is thus made more or less air tight. The size of the opening can be varied according to the size of the skin lesion by the use of various sized inserts. With this device, the underlying tissues receive only scattered radiation, and because of the thinness of the irradiated tissue, almost uniform distribution of dose is obtained. It is not recommended for the treatment of skin malignancies, however.

Its construction and use are discussed in detail.—*Z. Petrany, M.D.*

COCCHI, UMBERTO. Die Tumoren im Kindesalter. (Tumors in childhood.) Strahlenthera-

pie, June, 1958, *106*, 163–190. (From: Radiotherapeutische Klinik der Universität, Zürich, Switzerland.)

This article is a review of experiences at the Radiotherapeutic Clinic of the University in Zürich, plus a survey of an extensive list of references dealing with tumors in children. These are some of the conclusions and observations:

From 0.4 to 0.6 per cent of all cancer deaths occur in children.

Approximately 3 per cent of patients with malignant tumors at the Radiotherapeutic Clinic in Zürich were under sixteen years of age.

The increased statistical frequency of cancer in children is mainly the result of the decreased mortality rates from other children's diseases and the improved diagnostic methods.

The sarcomas and carcinomas have shown less increase in frequency than have the brain tumors and the leukemias.

Most tumors in children occur in the first four years of life.

Almost half of the tumors treated in the Radiotherapeutic Clinic were tumors of the nervous system, chiefly intracranial tumors. In descending frequency, leukemias, lymphogranulomas (Hodgkin's disease), other tumors of the lymphatic system, bone tumors, and tumors of the urogenital system followed. These made up 92 per cent of all tumors in children.

Of the patients with brain tumors, approximately 18 per cent improved and became symptom free. Of the patients with other tumors, approximately 16 per cent are symptom free.—*Henry G. Moehring, M.D.*

ERRINGTON, R. F. Outline of probable world requirements of cobalt 60 for therapy machines. *Radiology*, April, 1958, *70*, 481–485. (Address: Atomic Energy of Canada, Ltd., P.O. Box 93, Ottawa, Canada.)

Based on the results of a questionnaire sent to eleven people in the United States and Canada, it is assumed that there will be 1,200 therapy units averaging 1,220 curies each in world service by the end of 1961, excluding the USSR and satellite areas. By applying certain mathematical principles, the theoretical number of units installed each year from 1951 to 1961 can be predicted. The actual number of units installed from 1951 through 1956 is in close agreement with the theoretical number for those years. Knowing the number of units to be installed each year, it is possible to calculate the amount of cobalt 60 required to equip and maintain the units. Cobalt 60 required for replacement of decayed sources is based on 17 per cent per annum of the cumulative amount in service at the end of the prior year. This provides for scrapping of most of the therapy sources after a five-year decay period.

On the basis of present production figures and known plans for expansion, the supply of high activity cobalt 60 will be more than adequate to equip new machines, or renew sources in old machines, at least for the foreseeable future.—*Walter H. Jarvis, Jr., M.D.*

TSIEN, K. C., and ROBBINS, ROBERT. A comparison of a cobalt-60 teletherapy unit and a 2-MEV Van de Graaff x-ray generator on the basis of physical measurements. *Radiology*, April, 1958, *70*, 486–502. (Address: K. C. Tsien, Temple University Hospital, 3401 N. Broad Street, Philadelphia 40, Pa.)

A cobalt 60 teletherapy unit and a 2 mev. Van de Graaff generator are compared on the basis of physical measurements. Both units were installed in the Department of Radiology, Temple University Hospital, Philadelphia, at about the same time. Extensive physical measurements of both machines were undertaken and are reported in detail.

The measurements were done chiefly in three stages. In the first stage, the effects on the output of radiation by all relevant factors, such as field size, distance, beam circuit, and voltage, were studied. In the second stage, the relationship between the central-axis depth dose, the thickness of overlapping tissue, and the field size were determined. Depth doses were measured in a tissue-equivalent wax mix "D" phantom with the 3 mm. diameter ionization chamber of Fedoruk and Johns' design. Isodose curves for both the cobalt 60 unit and the 2 mev. Van de Graaff generator were measured in a water phantom. Surface ionization effects resulting from covering materials overlying the irradiated region were also determined.

Results of these studies are reported in the form of graphs and tables which present the physical measurements of the two machines side by side to emphasize differences and points of similarity.—*A. W. Sommer, M.D.*

PFALZNER, PAUL M. Transit-dose measurements in cobalt-60 rotation therapy dosimetry. *Radiology*, April, 1958, *70*, 503–506. (Address: Victoria Hospital, London, Ontario.)

The conventional methods of rotation dosimetry based on the concept of "tumor-air ratio" assume that the absorbing medium is homogeneous and water-equivalent. With cobalt 60 rotation therapy this may lead to discrepancies of 20 to 30 per cent between calculated and measured doses. This can be corrected by applying transit-dose measurements (described by the author in a previous publication) and the "transmission ratio" to calculate an equivalent thickness of homogeneous water-equivalent absorber and to construct an "equivalent outline" for the patient in question and for the particular conditions of

irradiation. The usual method of dosage calculation is then applied to this outline to find the "corrected" tumor-air ratio for each radial distance, the average of which, when multiplied by the output in r per minute in air at the center of rotation, gives the tumor dose rate. The procedure of taking tumor-air ratios for each radial distance and then averaging can be simplified by first finding the average radial distance, and then use a single corresponding value of the tumor-air ratio. Also, in the case of transmission ratios, it is possible to reduce the equivalent patient outline to a circle by averaging the equivalent radial distances. It is more convenient, however, as well as accurate, to integrate the transit dose over a complete rotation cycle with an integrating dose chamber and then to calculate from the integrated transmission ratio an average equivalent radius. Alternatively, one can read the corresponding tumor-air ratio directly from a family of graphs of transmission ratio versus tumor-air ratio with field size as parameter.

In summary, for all body sites where one may take the irradiated tissues to be water-equivalent, the average body radius may be used to calculate tumor dose in cobalt 60 rotation therapy. Wherever the tissues depart markedly from water-equivalence, the integrated transmission ratio enables one to reduce the irradiated medium to a water-equivalent one.—*Walter H. Jarvis, Jr., M.D.*

Haynes, Robert H., and Froese, Gerd. Averaged tumour-air ratios for 360-degree cobalt-60 rotation therapy. *Radiology*, April, 1958, *70*, 507–515. (Address: Victoria Hospital, London, Ontario.)

Tables of averaged tumor-air ratios in terms of the anteroposterior dimension and the ratio of the lateral to the anteroposterior dimensions of the patient are presented for cobalt 60 radiation, 360° rotation and 16 field sizes. The method by which these tables were calculated is outlined and their use is discussed and illustrated.

Basically this method depends on the fact that the actual body contour can be replaced by a trigonometric function following which the tumor-air ratio, written as a function of the radius, can then be integrated around this "idealized" contour.—*Donald N. Dysart, M.D.*

Alpen, E. L., Jones, D. M., Hechter, H. H., and Bond, V. P. The comparative biological response of dogs to 250-kvp and 100-kvp x-rays. *Radiology*, April, 1958, *70*, 541–550. (Address: E. L. Alpen, Biophysics Branch, U. S. Naval Radiological Defense Laboratory, San Francisco 24, Calif.)

Mongrel dogs weighing between 7 and 15 kg. were given bilateral total body irradiation to determine the comparative biologic response to 250 kv. peak and 100 kv. peak roentgen rays. Doses of 250 kv. peak roentgen rays ranged from 200–400 r and of 100 kv. peak roentgen rays from 450–775 r. Hematologic studies included white blood cell, red blood cell and platelet counts and hematocrit. Results of the changes in these measurements before and after irradiation are tabulated for each dosage schedule used. Depth dose determinations were made in a water-filled phantom with bakelite ionization chambers, and bilateral depth dose curves for each total dose were measured directly with an equally divided exposure. For the purposes of this study, although not entirely satisfactory, the dose to the median sagittal tissue plane was used as the most closely accurate criterion of measurement of the relative biologic effectiveness of the two qualities of radiation. The LD 50 was calculated for each treatment and the results tabulated. The mean survival time and the survival-decedent ratios are also tabulated for each quality of radiation.

Various other methods of measuring the relative biologic effectiveness of different qualities and types of ionizing radiation are discussed. There is no single method which can accurately correlate the biologic effectiveness with the physical dose over a wide range of energies.—*Z. Petrany, M.D.*

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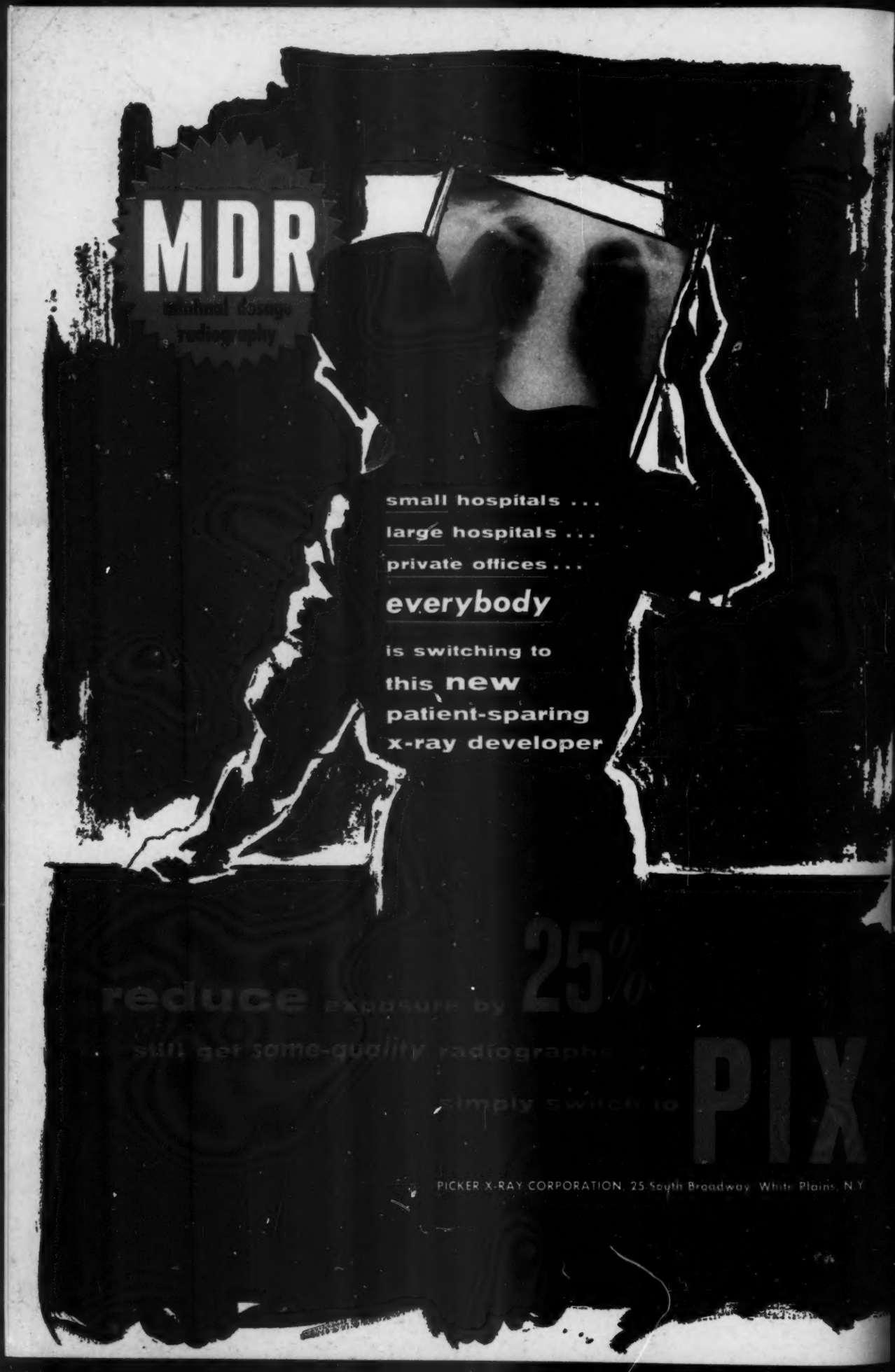
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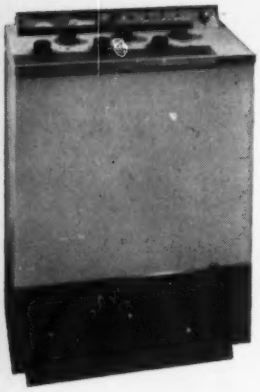

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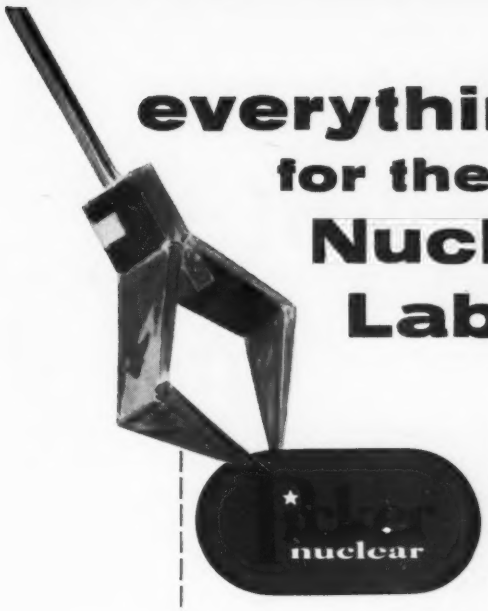

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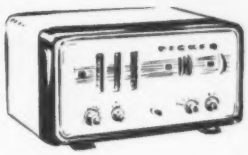

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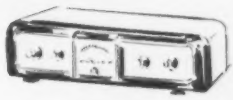

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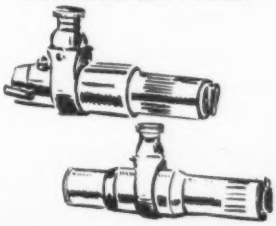

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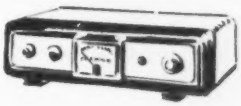

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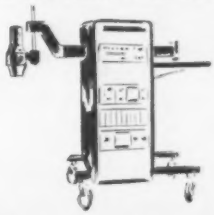

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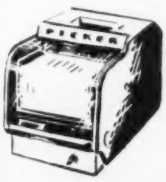

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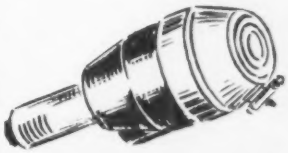

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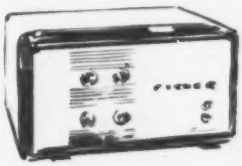

y the trained Picker national Service Organization with local Sales

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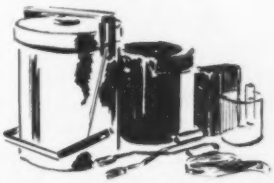

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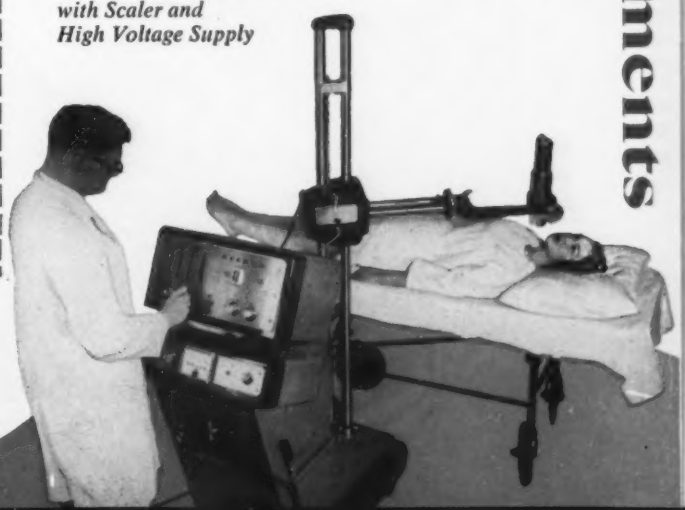
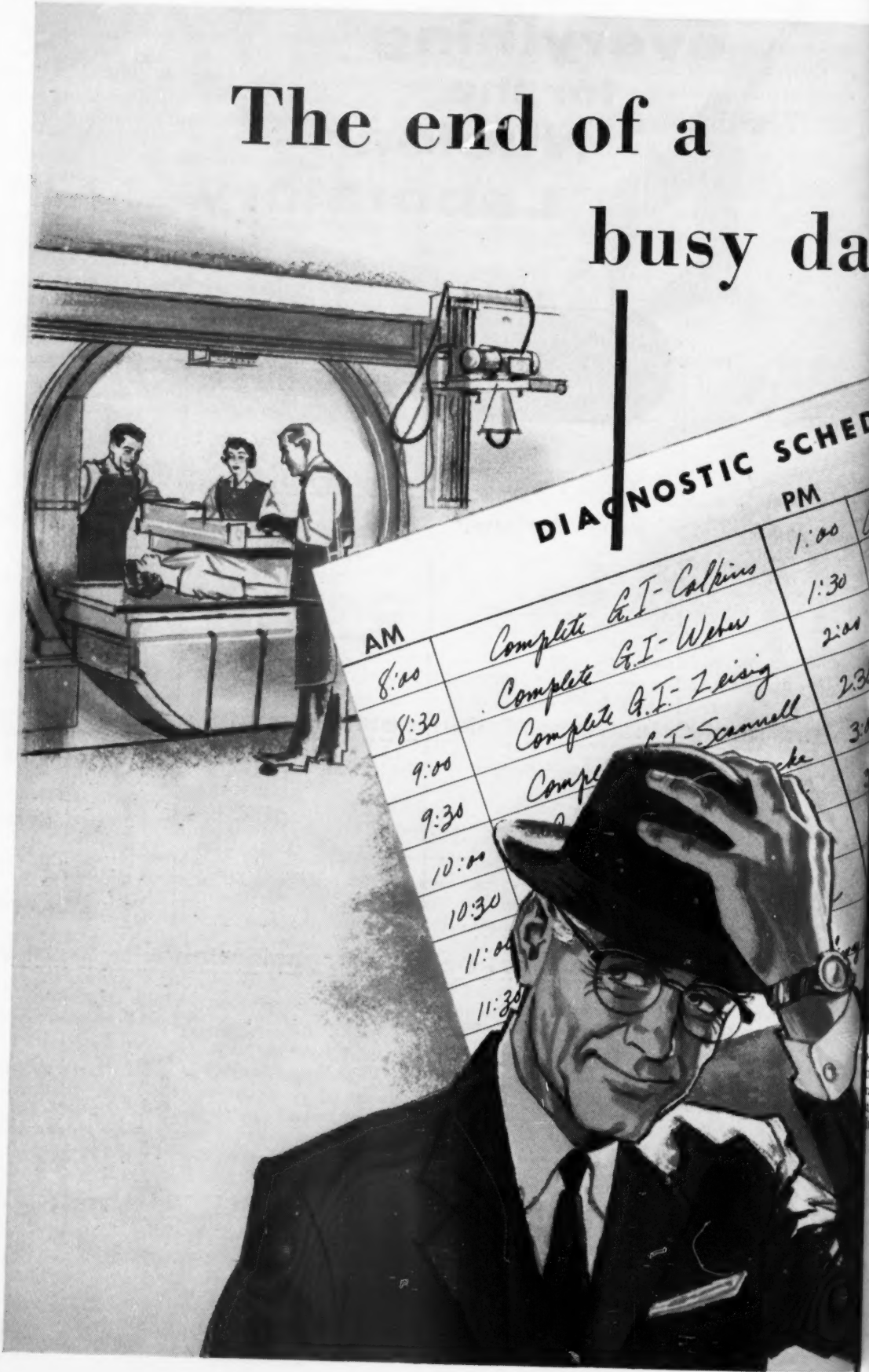


Get the story from your local Picker man. There's probably a Picker District office near you (see local 'phone book) or write Picker X-Ray Corporation, 25 South Broadway, White Plains, New York.

PICKER nuclear instruments

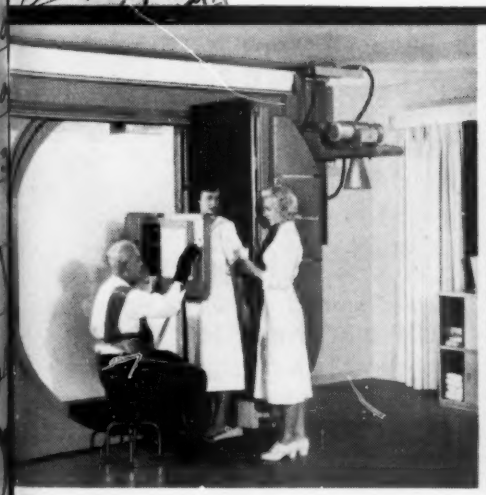
The end of a busy da



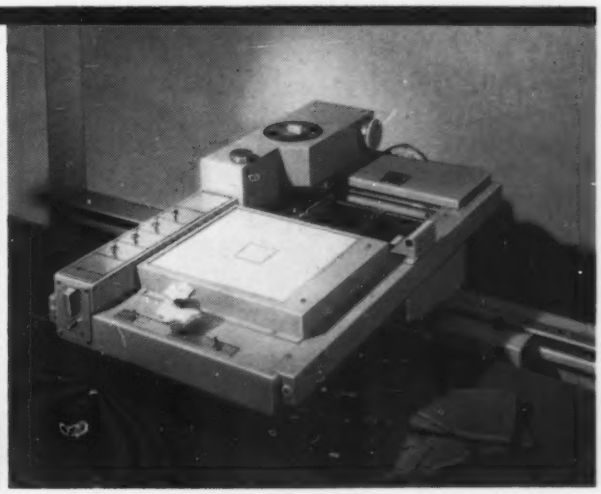
That's just one of the countless times you'll be glad you selected your G-E Imperial— with radiologist-guided design

Today's taxing diagnostic x-ray schedules with extended periods at fluoroscopy, make it *especially important* to demand the freedom from strain and heavy effort built into the Imperial. Diagnostic ease with the Imperial is the result of radiologist-guided design. Easy-steering automatic spot-film device, finger-tip controls, sealed spot-film phototiming, ring-centered table angulation — these are just a few of the ways Imperial lightens work pressure . . . and *lightens your step* at the end of each busy day.

MEET THE IMPERIAL PERSONALLY! Your G-E x-ray representative will be happy to introduce you to one in your area. Or write X-Ray Dept., General Electric Co., Milwaukee 1, Wisconsin, for Pub. A-121.



-saving, ring-mounted table — provides unob-fted view of fluoroscopic screen from a single alized position throughout complete range of an-ion. 180° angulation permits left-hand operation ustrated.



Finger-tip controls, conveniently grouped on spot-film device. Also light-tight, dust-proof phototimer detector; automatic cassette transfer and return; automatic exposure sequencing; dual-speed table angulation; electric locks for all viewing-screen movements.

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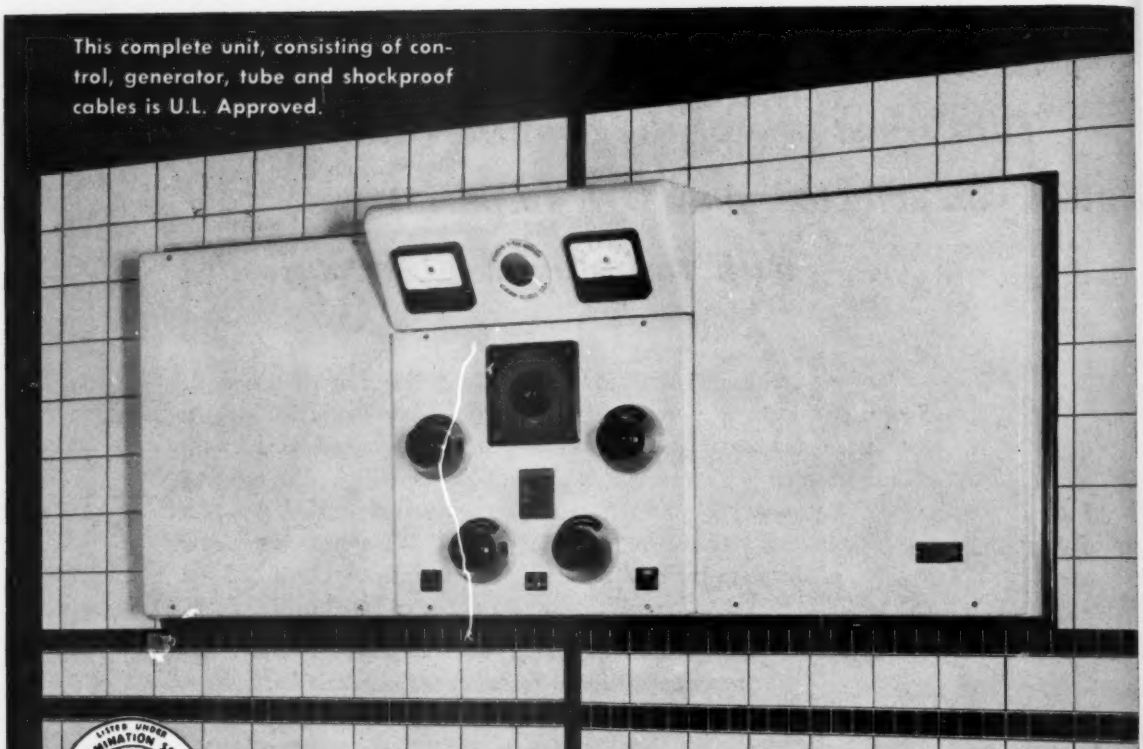
GENERAL ELECTRIC



This complete unit, consisting of control, generator, tube and shockproof cables is U.L. Approved.

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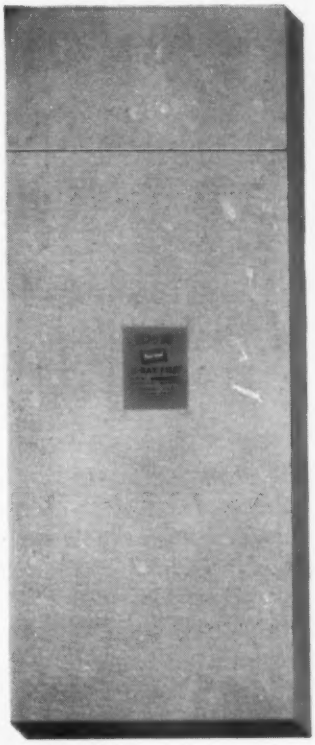
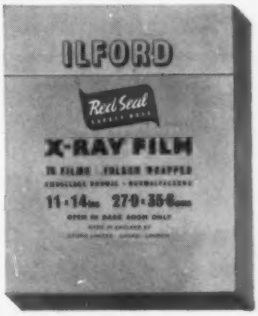
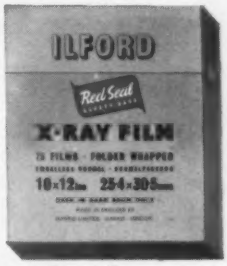


14" x 36"



11" x 14"



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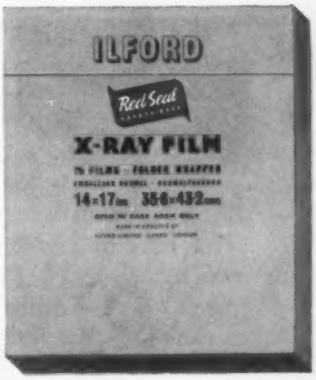

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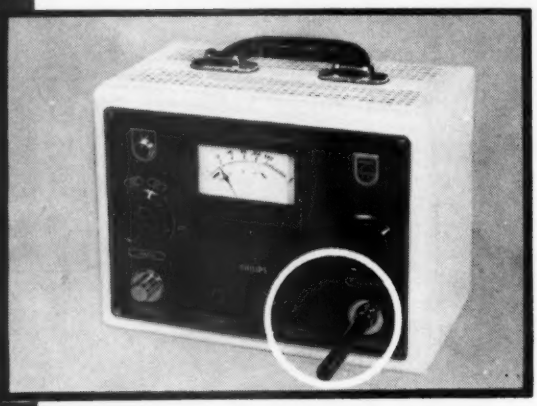
PERSONNEL MONITOR



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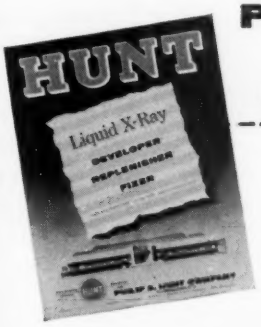

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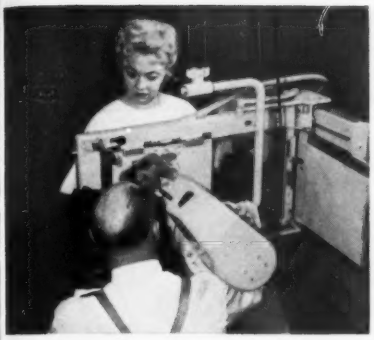

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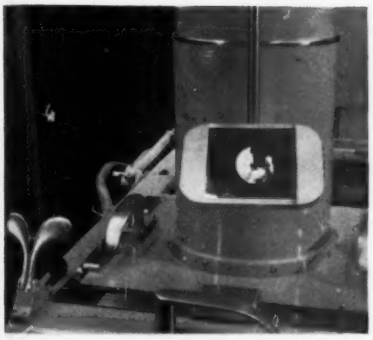

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Lloyd, F. A., and Braman, Robert (Northwestern Univ.): An evaluation of Hypaque as a urographic medium, read at meeting of North Central Soc. Am. Urological A., Cleveland, Oct. 3 to 5, 1956.

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Johnson, P. M. (Univ. North Carolina): Oral cholecystography, *North Carolina M. J.* 18:533, Dec., 1957.

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"...the need for a contrast medium that would be of uniform and reliable visualization for all the ducts, especially in the patients having had cholecystectomy, was not met until the introduction of Cholografin."[1]

"...a reliable method for rapid visualization of the biliary tract irrespective of whether or not the gallbladder is present and independent of its ability to concentrate its contents."[2]

"Side reactions to Cholografin are less than those observed during an intravenous urographic examination."[3]

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Cholografin Sodium: 2 x 20 cc. ampuls, each with 1 cc. ampul for sensitivity testing.

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1. Reeves, R. J.: Southern M. J. 50:1377 (Nov.) 1957.
2. Shehadi, W. H.: Am. J. Gastroenterol. 28:236 (Sept.) 1957.
3. Sachs, M. D.: J. Internat. Col. Surgeons 27:681 (June) 1957.

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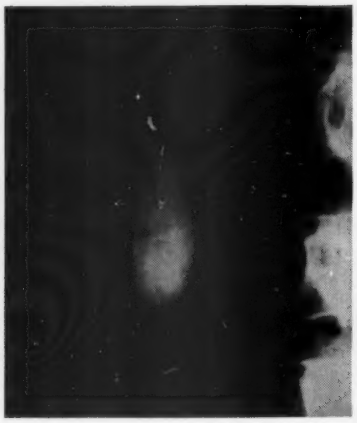
Actual unretouched X-ray of gall bladder. Note lack of gray-scale contrast in suspect area.



The same X-ray showing contrast enhancement by EXICON. Note clarity of detail in suspect area.

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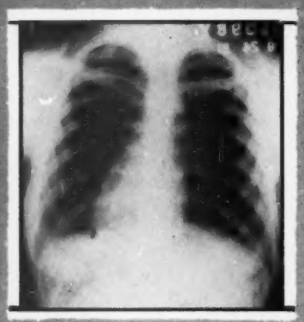
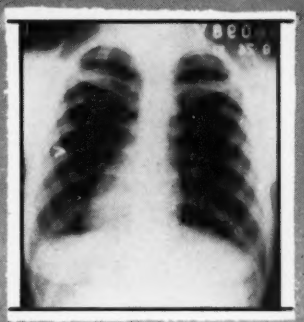
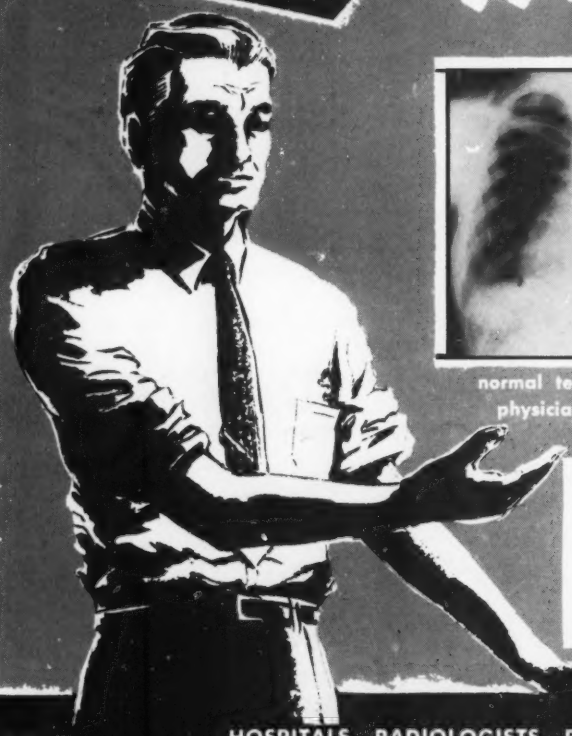


normal technique in physician's office



same patient, same factors reduced exposure 25%



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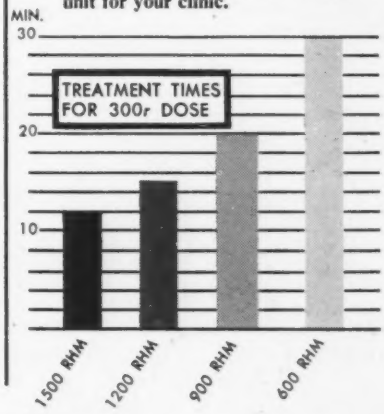

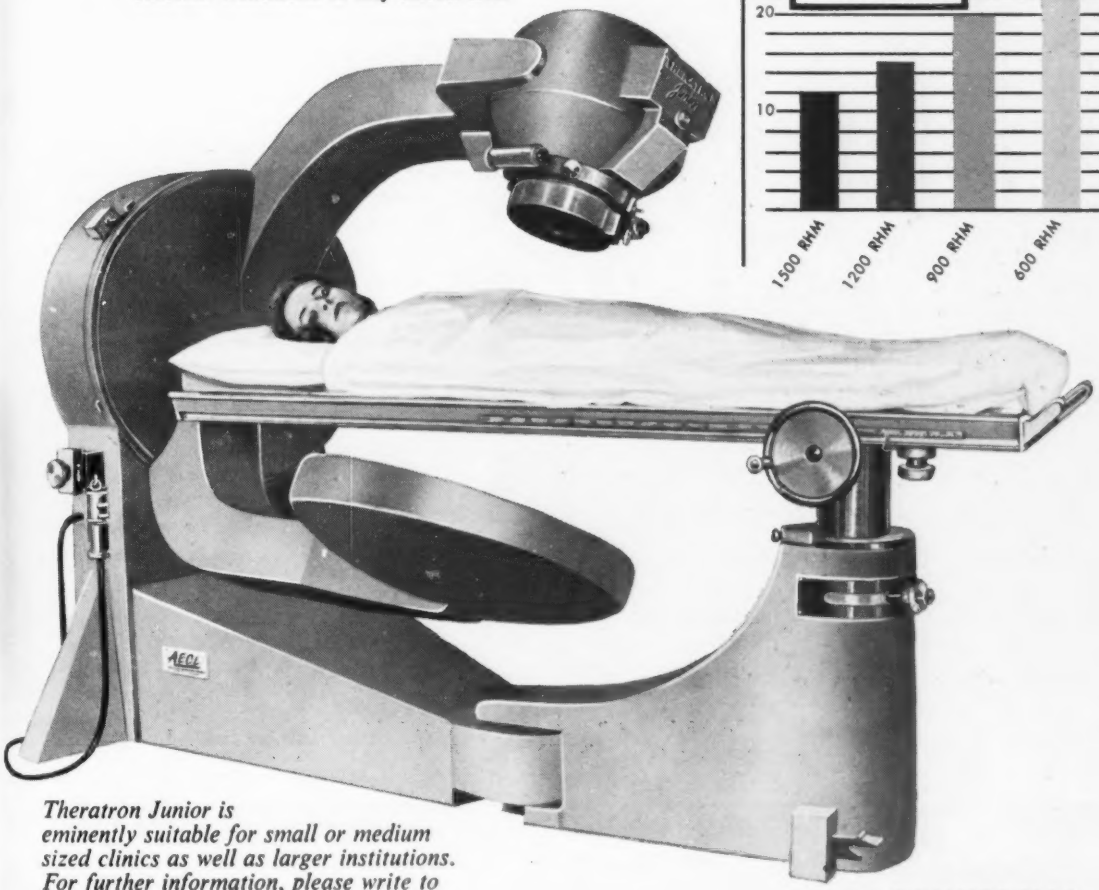

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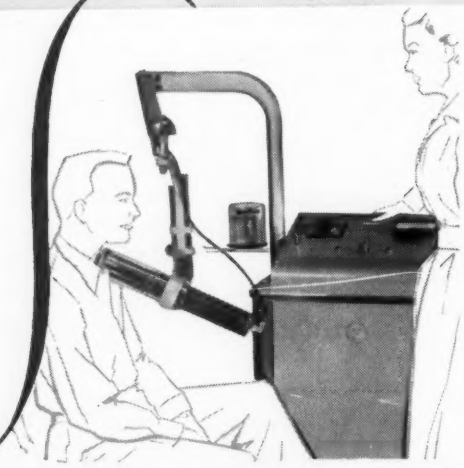

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with minimum concentration

in this newly packaged, convenient-to-use medium

CONVENIENCE Sterile solution PYELOKON-R is packaged in 50-ml rubber-diaphragm-stoppered bottles. Solution remains sterile for second examination. It is ready to use—without diluting.

SAFETY PYELOKON-R is extremely well tolerated by the mucosa of the urinary tract. Its basic composition is the triiodo molecule, sodium acetrizoate—widely used as an intravenous contrast medium.

FOR SUPERB VISUALIZATION . . .

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BRAND OF SODIUM ACETRIZOATE SOLUTION 20%

FOR RETROGRADE PYELOGRAPHY

CONTRAST PYELOKON-R has been specifically formulated for retrograde pyelography. Its radiopaque component is a triiodo compound of higher iodine content, and thus PYELOKON-R provides optimum contrast with minimum concentration. In addition it diffuses more rapidly in the urine than earlier mono and diiodo type preparations.**

** Richardson, J. F. & Rose, D. K.: J. Urol. 63:113 (1950).

* Trademark

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'Thorazine' relieves the anxiety and tension that intensify pain, thus reducing the patient's suffering and making him easier to care for.

'Thorazine' stops nausea and vomiting whether caused by the malignancy or by distressing therapies.

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  dose calculation unnecessary, even for obesity
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  avoids diarrhea and dysuria
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  calculi clearly delineated

Dose and Procedure: Six capsules should be swallowed, one at a time, approximately 12 to 14 hours before the examination. No variation from the usual manner of patient preparation is necessary.

ORABILEX (Bunamiodyl), a new chemical compound, is 3(3-butyrylamino-2,4,6-triiodophenyl) ethyl sodium acrylate. It contains 57% iodine.

For detailed description consult FOUGERA literature.

Packaging: ORABILEX Capsules are supplied in envelopes of 6 capsules (0.75 Gm. each). Boxes of 5, 25, and 100 envelopes; also available in hospital-size bottles of 250 capsules.

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RA[illegible]lecystographic agent

ORABILEX*

[illegible]ximal visualization with minimal disadvantages to patient and physician

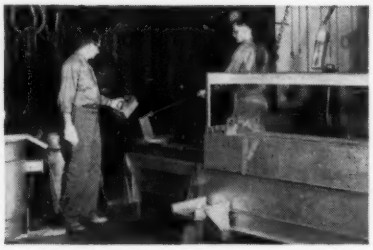
new model JUNO *offers* 4 *new features!*

New Model 6 JUNO

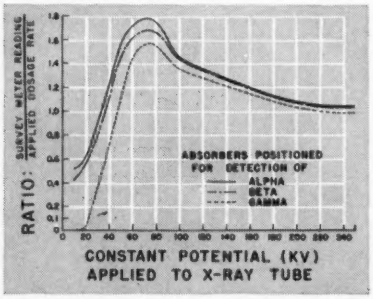
- Removable battery pack.
- Easily replaceable alpha screen.
- Large easy-to-read meter face.
- Hard-chrome plated aluminum case.

The Juno Survey Meter

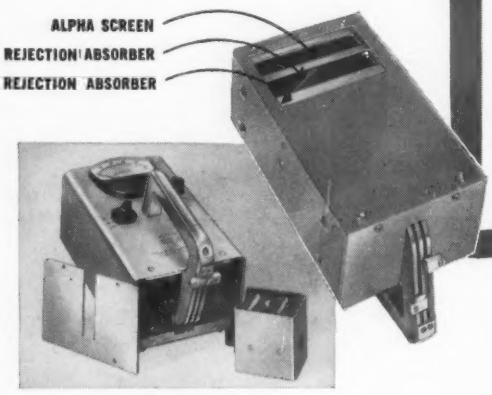
is a portable, battery-operated instrument which measures the intensity of, and distinguishes between alpha, beta, and gamma radiation. It is an improved version of the original Hanford instrument and is used to protect personnel from the danger of over-exposure to radiation from radioactive materials or X-rays. While primarily intended for inspection of flat surfaces, the Juno is suitable for most uses where a high degree of accuracy is desired.



Juno is shown in use at the Admiral Corporation Nuclear Radiation Laboratory, monitoring sample for radioactivity.



Juno can be used for X-ray detection and measurement by reference to the above curves.



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AVAILABLE In 2 MODELS

SRJ-6 Juno (Standard Range):
50, 500, 5000 MR/HR full-scale.

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Both Models meet A.E.C. specifications.

For complete details, write for Bulletin No. 159.

TECHNICAL ASSOCIATES

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better radiation protection

top .....front

bottom.....

..... back

...both ends

wherever you stand at a Constellation Table—whether you're the presiding radiologist or a team member—you have the peace of mind that comes of knowing how *well protected you are*. That goes for any of the Constellation models shown below. Common to *all* are the fully-enclosed steel table body, the automatic Bucky slot closure, the close-collimated radiation beam, the fully-leaded spotfilm device. There's even a hinged stainless steel shield (see picture) to protect the radiologist against radiation scatter from the patient. He merely flips it up whenever he fluoroscopes. Any Constellation table can be so fitted (optionally).

wider s·p·r·e·a·d of models

90 to 90° vertical

90°

45° Trendelenburg

45°

or even 15° back tilt

15°

if that's what you want

There's virtually *nothing* in the way of diagnostic radiography you can't do with this magnificent table. You can fluoroscope (with an 8″ Image Amplifier, if you like) or radiograph a patient hanging head down vertically, or in any other position you can conjure up.

if that's all you need

Without wishing to become involved in range-of-angulation pros and cons, we can report that *most* Constellation buyers are content with this 45° model. (Extra angulation costs extra money—a hard engineering fact of life that may have something to do with it)

if you'll settle for that

The less elaborate drive mechanism required for this moderate angle of tilt results in significantly lower cost. If 15° Trendelenburg is enough for you, this model is far and away the best buy around.

you'll be better protected, better served with a

***Picker* Constellation**

diagnostic x-ray table

Your local Picker representative stands ready to give you a quick rundown on the many other Constellation features that radiologists find so appealing. Call him in any time... or write
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4 MILLION ELECTRON-VOLT LINEAR ACCELERATOR

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for Super Voltage X-Ray Treatment

X-Ray dose rates at 1 meter with radiation collimated to give an effective source diameter of 5 mm. and filtered to give uniform intensity over a field area of 25 x 15 cms.
350 r/min. at 500 pulses per second.
280 r/min. at 400 pulses per second.

Field Areas
Maximum ... 30 x 20 cm.
Minimum ... 3 x 3 cm.

Electron Output
Electron beam energy (mean value) 4.3 MeV
Electron beam power (maximum) 850 Watts
Electron beam current in each pulse 240 mA
Electron beam diameter at accelerator output 90% within 1 cm.

Here is the most advanced equipment in the world for effective deep therapy.

Three major Radiotherapeutic centers have tested this Linear Accelerator through daily use. It gives more effective treatment than Cobalt 60 or conventional X-Ray methods . . . minimises the risk of damage to skin tissues . . . uses higher dose rates, cutting treatment times considerably.

The equipment is designed on the gantry principle, so that the primary beam at one meter rotates about a given point in space (the isocenter), in which all lining up procedures are centered. It provides Arc, Rotation and Electron therapy.

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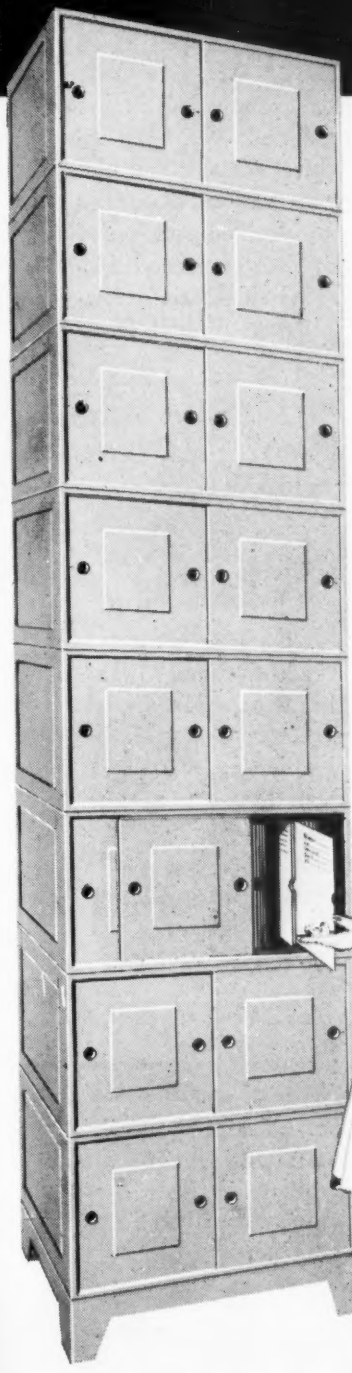

- Because each "File-Stak" holds approximately 800 films, you can file more.
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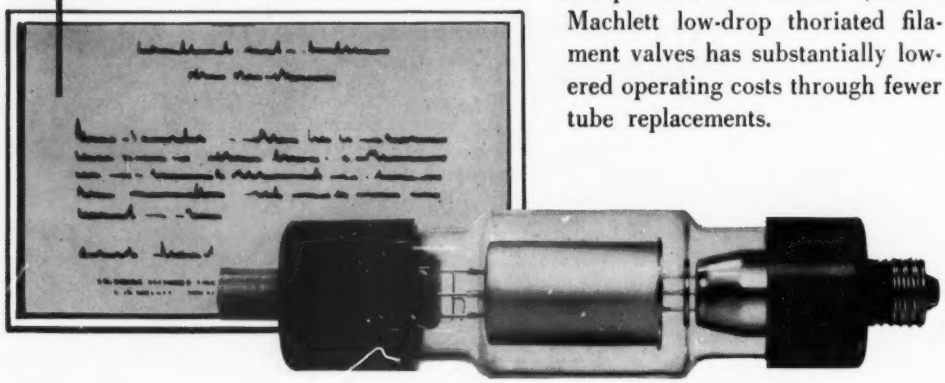
An extended Warranty on Machlett Low-Drop Valve Tubes

The introduction several years ago of thoriated tungsten filament valve tubes provided what time has proven to be the ideal rectifiers for use with x-ray apparatus. In addition to the advantages of consistent subject contrast and film density, superior performance unaffected by line voltage fluctuations, longer life independent of load current, use of Machlett low-drop thoriated filament valves has substantially lowered operating costs through fewer tube replacements.



The outstanding performance of ML-41 & ML-46 valves in particular, when used in conventional equipments — more than double the life experienced with previous valves — can be further enhanced. Life expectancy can again be doubled when these tubes are operated in equipments employing special preset filament voltage controls. Machlett Laboratories, with the introduction of these relatively inexpensive equipment modifications, is prepared to extend its warranty period on these types. ML-41 and ML-46 valve tubes, when operated in approved equipments, will be warranted to be free from manufacturing defects which impair their operating life for a period of 10000 hours of filament life or 5 years whichever occurs first.

Write today for full technical data on all Machlett rectifier tubes for x-ray service.

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X-RAY TUBES SINCE 1897 — TODAY THEIR LARGEST MAKER

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LEAD RUBBER APRON
GHS 12 POUNDS

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Weighs
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...for modern-day radiation protection it's

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CAT. NO.	DESCRIPTION	WEIGHT*	PRICE
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B451	Single layer gown—medium	4½ lbs.	129.00
B452	Single layer gown—large	4¾ lbs.	138.00
B454	Single layer apron	1½ lbs.	45.00
B455	Patch on mid-body—12" high	2 lbs.	24.00
B456	Yard goods	Sq. yd. 3 lbs. Per sq. yd.	42.00
B821	Single layer coat type without sleeves	3¼ lbs.	60.00
B822	Single layer 12" square apron with ties	4 oz.	10.50
B823	Single layer 12" x 24" apron with ties	8 oz.	21.00
N587	Monitoring Service		11.00

*Approximate

75 KV (0.5mm A1)	One layer of cloth transmits 15% Two layers of cloth transmits 6% Three layers of cloth transmits 4%
100 KV (1.2mm A1)	One layer of cloth transmits 25%
135 KV (3.4mm A1)	One layer of cloth transmits 45%

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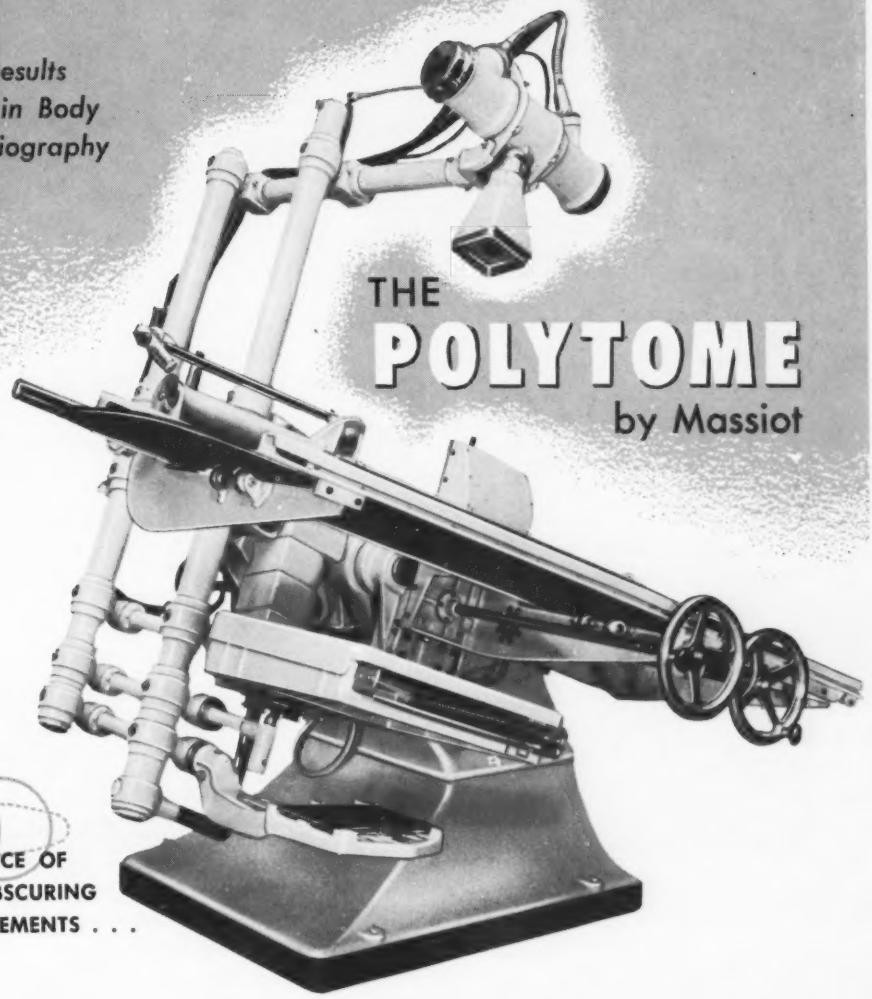

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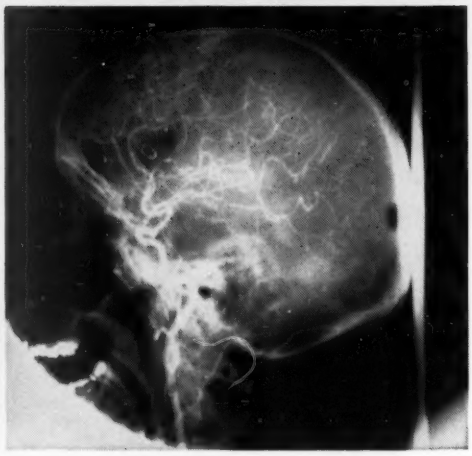
Notes on the Sanchez-Perez UNIVERSAL AUTOMATIC SERIOGRAPH



The Seriograph can be used for a variety of procedures. Illustrated is cerebral angiography

Technique: Suggested for Lateral Projection, 1/10 sec. 300 M.A. 74 K.V. 40″ distance with cone to cover 10″ diameter. Par speed screens or equivalent. 1/2 second interval. 3mm., AL filters added.

Distribution: The Seriograph is distributed by all major X-Ray companies and their dealers. Contact them, or Automatic Seriograph Corporation for additional information and an illustrated brochure on Model 110.

the AUTOMATIC SERIOGRAPH CORP.
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Localizing accumulated radioiodine in thyroid remnants with the 6 mm needle probe to assure complete thyroidectomy.

New Versatile Nuclear-Chicago Beta-Gamma Scintillation Probe

Needle probes are provided in these sizes:
2 mm x 10 cm (2.5 mil stainless steel wall)
3 mm x 10 cm (2.5 mil nickel wall)
6 mm x 15 cm (2.5 mil nickel wall)
All probes are easily interchanged by loosening and tightening a simple hand nut.

Designed for the surgeon, radiotherapist or gynecologist, the new Nuclear-Chicago Model DS8 Scintillation Detector is ideal for application in brain tumor localization, pinpointing radioisotope concentrations in thyroid or neoplastic tissue, and estimating radiation doses in radiotherapy. The detector, with three unique, interchangeable needle probes, is a compactly-designed, convenient, lightweight instrument with the complete reliability and accuracy so essential to medical applications.

This rugged detector weighs less than 5 ounces and is only one inch in diameter. It can be sterilized in solutions commonly used in the operating room, is corrosion-proof, and its quality components provide practically infinite life. The beta-gamma sensitive crystals are mounted in the needles in such a way that the active volume is confined to the very tip of the probes.

For more than 12 years we have been designing and manufacturing for the medical profession high quality instrumentation for detecting and measuring radioactivity. We will be pleased to provide you with full information on the Model DS8 Scintillation Probe and on other Nuclear-Chicago instruments for clinical use.

Radioisotopes are creating new frontiers in medicine

nuclear-chicago
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This is a normal myelogram in which ***Pantopaque Contrast Medium*** outlines the lower lumbar subarachnoid space and the sacral cul-de-sac. It is an anteroposterior radiograph made with the spot-film device after tilting the patient to the semierect position on the fluoroscopic table. This is to be compared with the myelogram at the right showing herniation of the fifth lumbar intervertebral disk.

The left lateral aspect of the ***Pantopaque*** column in the subarachnoid space is smoothly indented at the level of the fifth lumbar-first sacral intervertebral space. The left nerve root is not filled, while the right sheath is well visualized.

"PANTOPAQUE" *is the registered trademark under which all leading x-ray dealers supply the compound ethyl iodophenylundecylate, which is synthesized by the Research Laboratories of Eastman Kodak Company and prepared as the myelographic contrast medium Iodophenylate Injection, U.S.P., by Lafayette Pharmacal Inc. The trademark serves to indicate to the radiologist continuity of experience in the manufacture of this medium.*

radiopacity: full

concentration: optimal

definition: sharp

visualization: clear

diagnosis: unmistakable

NEO-IOPAX®

sodium iodomethamate

local and systemic tolerance is excellent in

I. V. urography

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NO SHADOW OF A DOUBT IN CHOLECYSTOGRAPHY

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IN YOUR PICTURE
- No "overshadowing" by radiopaque material in colon.
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- Excellent visualization of normal gallbladder and frequently of extrahepatic ducts.

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- Extremely good tolerance—the lowest incidence of discomforting side actions.

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92-J-110

HERNIATED DISK
Radiographs—before surgery.
(For photographs of surgery—turn page.)

Routine lateral radiograph shows loss of normal lumbar lordosis, also spur formation.

Lateral radiograph (patient supine) with opaque oil in subarachnoid area shows anterior filling defect at the L4-5 disk space.

AP and oblique views show lack of filling of the nerve root sheath at L4-5 disk space.

Recording invisible... and visible

How radiography and photography complete the picture . . . help to accelerate medical progress, aiding diagnostician, surgeon, teacher and student.

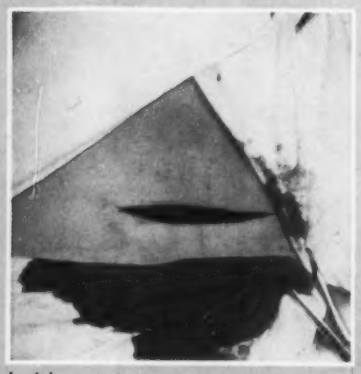
Here on this page and the page following you see highlights of an operation for the correction of a herniated intervertebral disk. First, radiographs that aid neurosurgeon and orthopedist in diagnosis, help guide the surgeon's fingers . . . then, color photographs of the surgery.

The complete picture is invaluable to medical progress. Radiographs and photographs work together to show what was seen and done. Such illustrations can be reviewed again and again . . . months, years later . . . in conferences, classrooms, and lecture halls; and they can be reproduced in textbooks and journals.

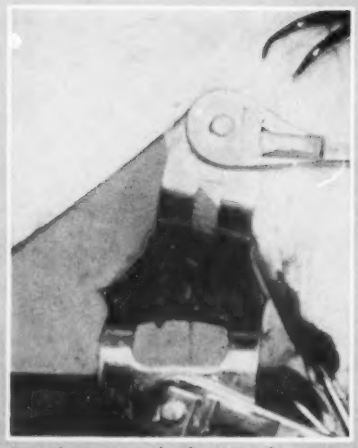
The cost? Small, considering the value of the documented results.

Koda

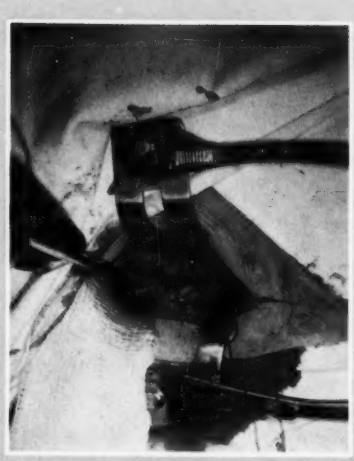
HERNIATED DISK
Photographs—surgical procedure.



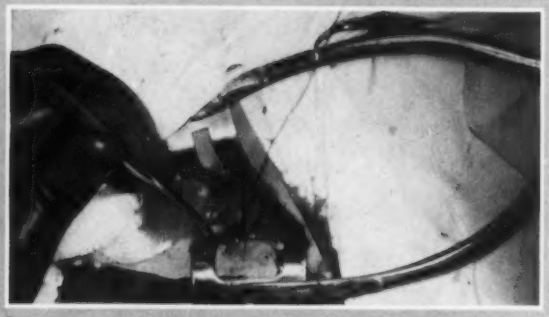
Incision.



Muscle stripped, showing lamina and interlaminar spaces.



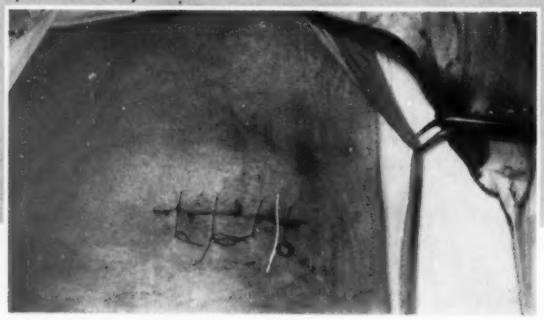
Ligamentum flavum removed and dura exposed.



Dura retracted, exposing flattened nerve root.

Nerve root retracted; disk sequestrum extrudes spontaneously.

Disk sequestrum being withdrawn.



Final closure.

For Radiography: Kodak Royal Blue Medical X-ray Film and Kodak x-ray processing chemicals meet the most exacting requirements. They are always dependable—uniform. Quality-controlled—rigidly tested—they are *made to work together.*

For Color Photography: Kodachrome Films for miniature and motion-picture cameras; Kodak Ektachrome Films and Kodak Ektacolor Films for sheet-film cameras; Kodak Ektachrome Films for roll-film and miniature cameras; Kodacolor Films for roll-film cameras and cameras accepting No. 828 film. Kodak color print materials are also available.

Order Kodak x-ray products from your Kodak x-ray dealer,
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Kodak

EASTMAN KODAK COMPANY, *Medical Division*, Rochester 4, N.Y.

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RADIOLOGICALLY IMPROVED

20% net iodine content provides optimal radio-contrast

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PRICE UNCHANGED

$1.75 per vial of 10 cc. In quantity as low as $1.50

MEDOPAQUE-H is an aqueous, sterile, viscous contrast solution containing 35% Sodium Ortho-iodohippurate, 10% Sodium Iodide and a blend of polyethylene glycols.

MEDOPAQUE-H HYSTEROGRAM

7 cc. of Medopaque-H dissemination in peritoneal cavity. Superb visualization of the cervix, isthmus corpus and uterine tubes.

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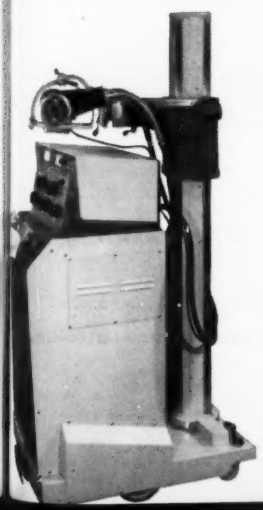

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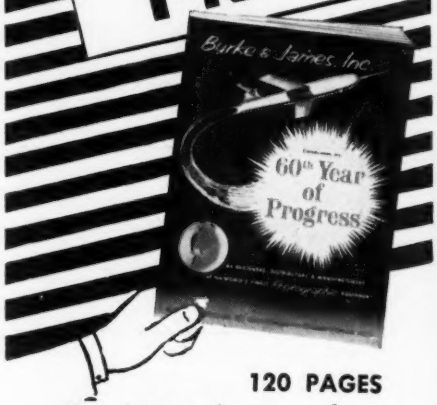

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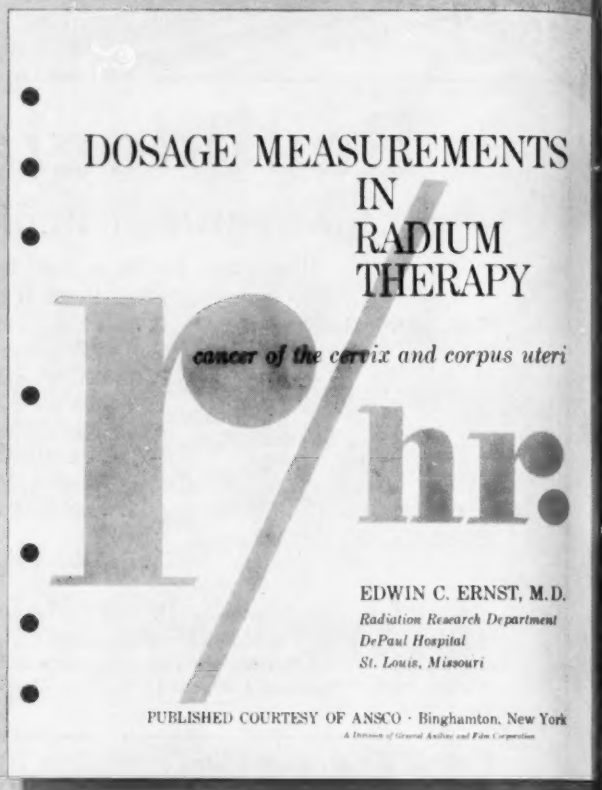

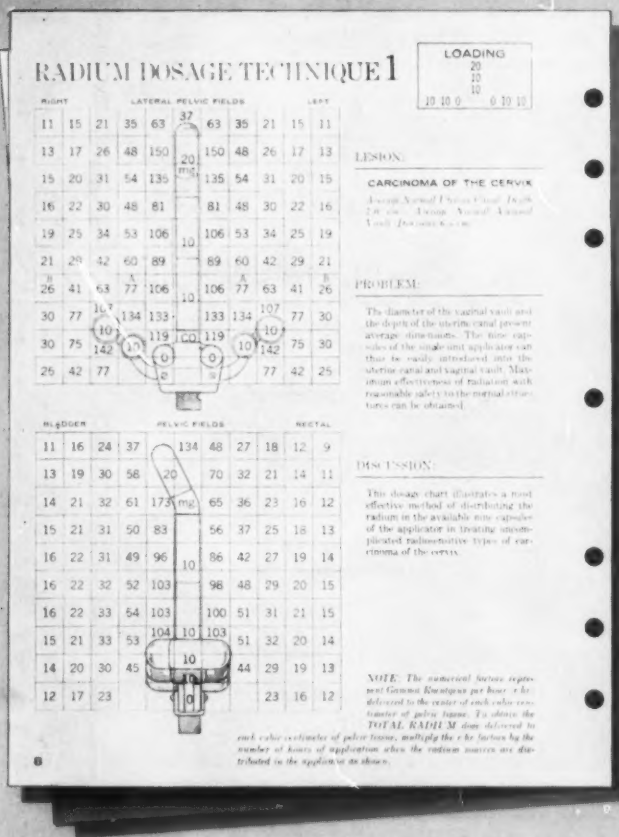
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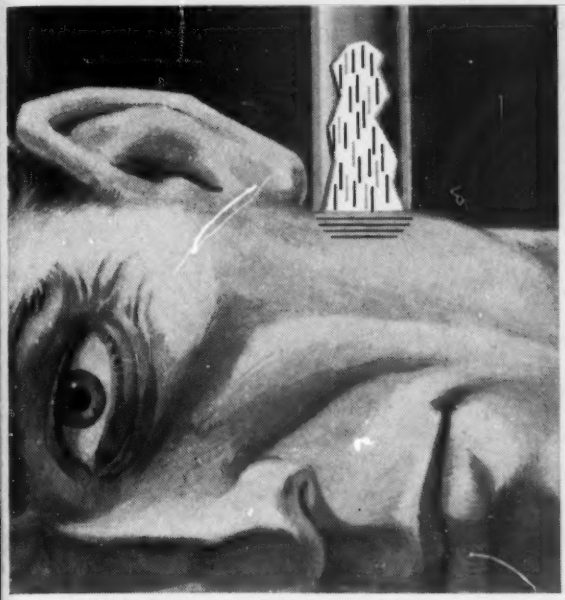

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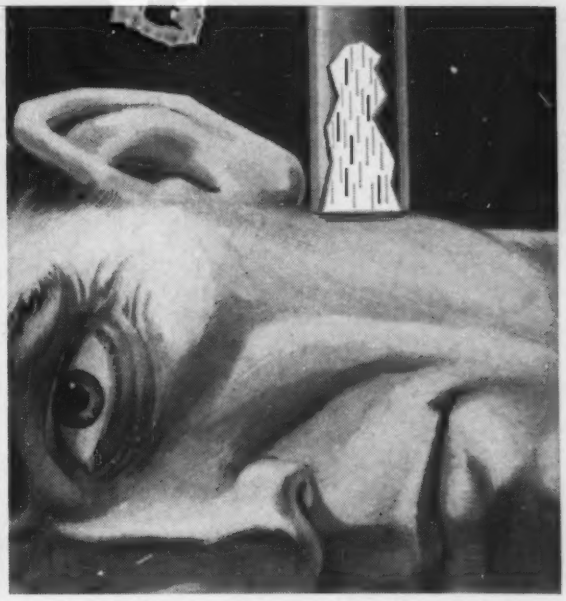

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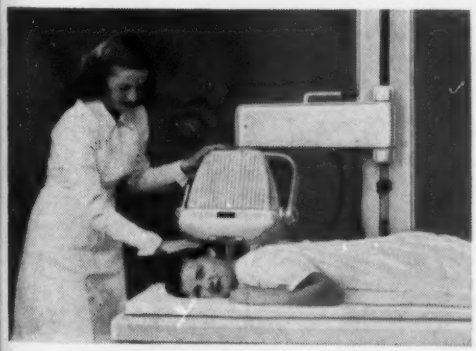

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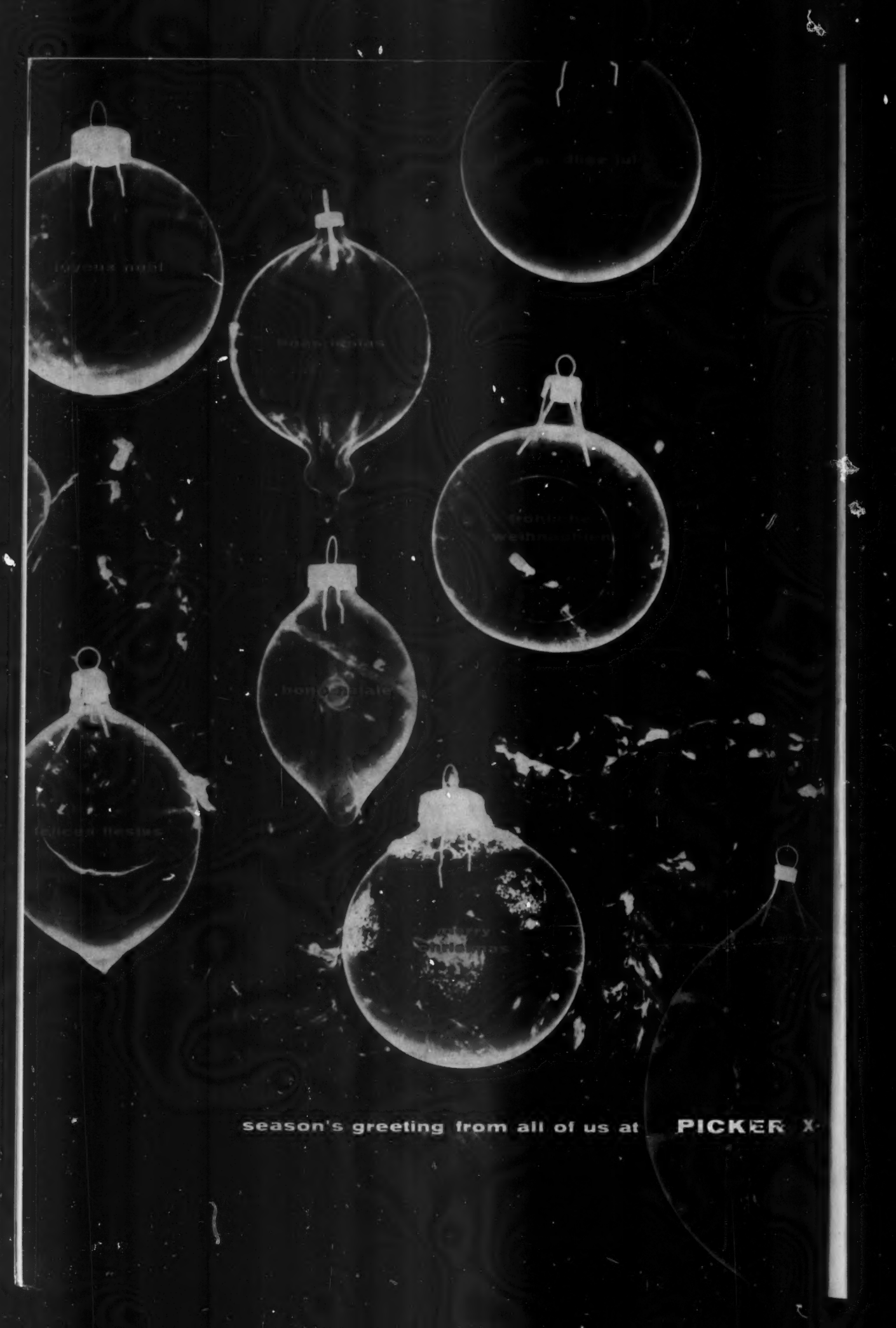
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